HE ENGINEERING CONSTRUCTION WEEKLY

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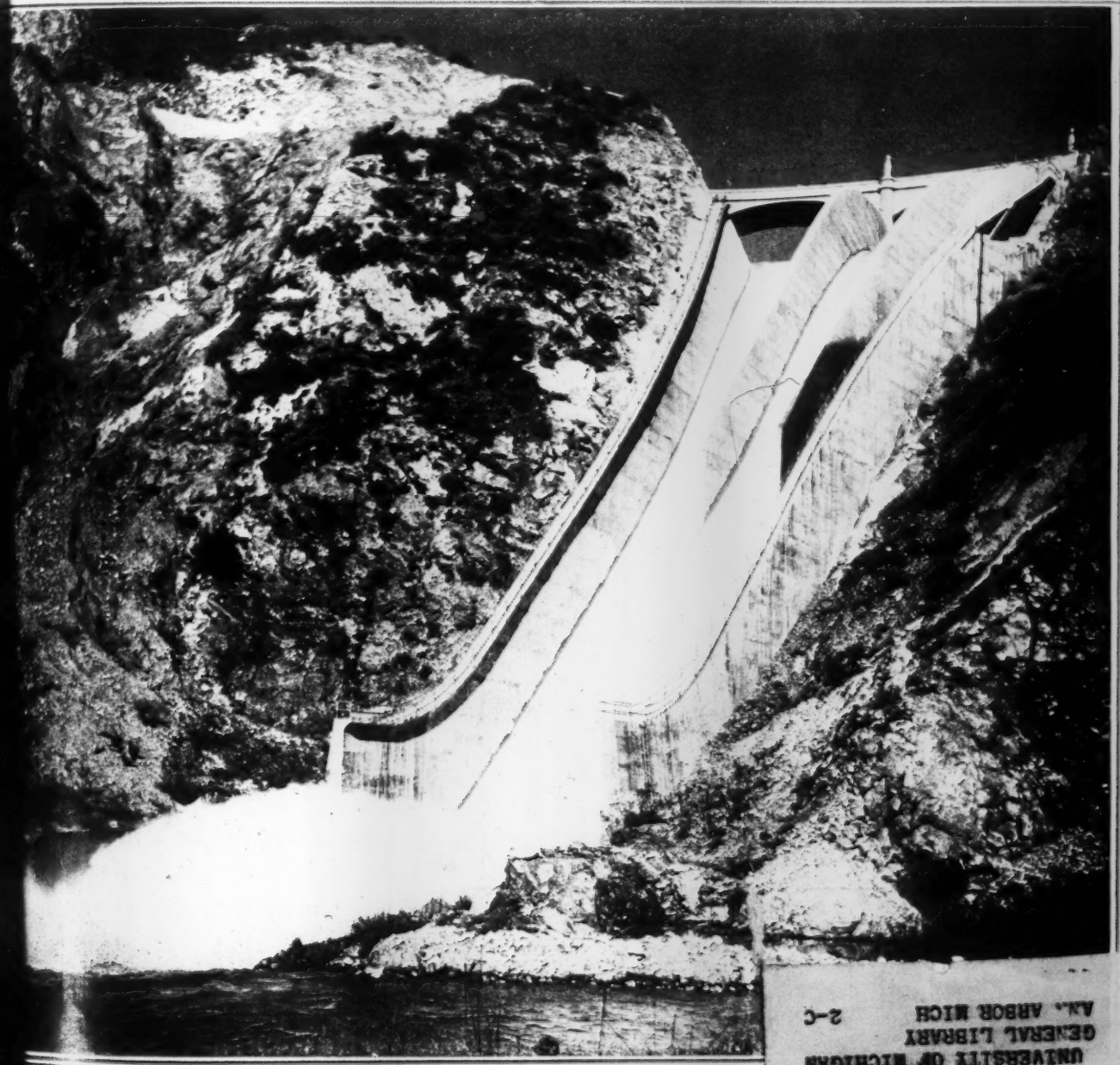

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McGRAW-HILL PUBLISHING COMPANY, INC.
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VOL. 120 *MARCH 3, 1938* No. 9

THIS WEEK AND NEXT

TUNNELING from shaft to shaft without instrument, human moles in the deserts of Baluchistan tap natural underground basins formed by detritus accumulation, and lead the water to the surface near villages at lower points on the sloping plain.

Conde McCullough, who is no stranger to News-Record *readers, presents a graphic method of determining the economic feasibility of a proposed highway project, in which he uses the three factors, costs, revenues and benefits, as bases for formulas.*

Drawing up specifications preparatory to bidding on sewage disposal jobs sometimes requires nice handling in order to avoid discrimination among equipment manufacturers. Suggestions for fair and effective competitive bidding are made on page 329.

Rebuilding the tower of Boston's Old South Church has been accomplished without interrupting use of the building or the normal traffic of the street, due to ingenious space-utilization and scaffolding.

Highway safety was stressed at the recent meeting of the Association of Highway Officials of the North Atlantic States.

Concrete finishing on the dished circular bottoms of the new sludge digestion tanks at Buffalo was no trouble for the contractor, for he devised a rotating truss screed that left a perfect surface.

Concrete box-girders of record 190-ft. span give graceful lines to a highway bridge over Henderson Bay of Puget Sound. F. R. Easterday covers the design features and construction of this bridge.

NEXT WEEK — In California's Santa Clara Valley, excellent results have been obtained in replenishment of underground water storage.

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THE COVER PICTURE is of the spillway at Morris Dam of the Pasadena Water Department, discharging 600 sec.-ft. The total capacity is 80,000 sec.-ft.

Photo by E. R. Hoge

Number of copies of this issue printed: 32,727

Unretouched photographs showing Atlas White portland cement curbing on the Hutchinson River Parkway Extension, Bronx County, N. Y. Installed by New York State Department of Public Works, Division of Highways. General contractor, Rusciano and Son Corp., New York City. Subcontractor (for curb work) W. B. Mallery, Astoria, N. Y.

SAFETY and economy—this well-engineered highway combines both! Traffic moves swiftly yet safely on either side of the center parkway. Curbing of Atlas White portland cement marks the traffic lanes clearly and distinctly.

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THE WEEK'S EVENTS

East Side Manhattan To Be Rezoned

Planning Commission plans to encourage residential development in East Side waterfront area

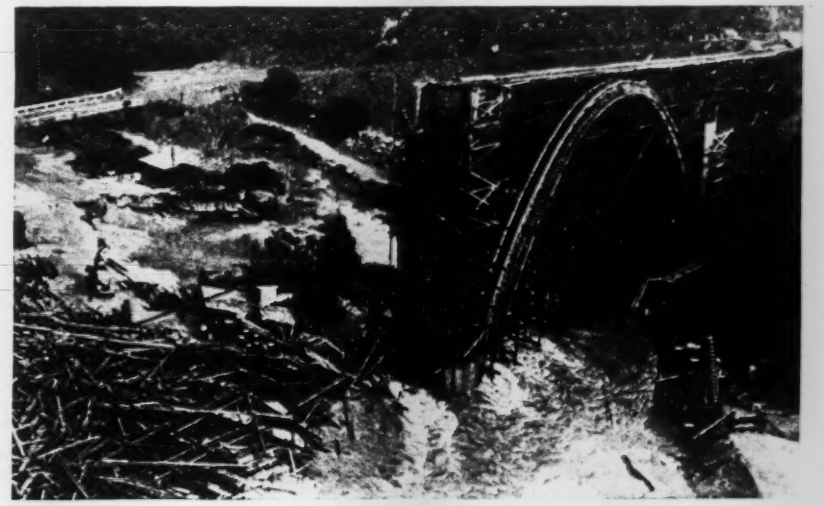
Rehabilitation of the lower east side of Manhattan, long a slum center, would be encouraged by a rezoning plan proposed by the New York City Planning Commission. The commission, a new body established under the city charter which went into effect the first of the year, has called a hearing for March 16 on the rezoning plan.

The area affected, extending from 14th St. a mile and a half south along the East River to the Brooklyn Bridge, is now largely zoned for unrestricted use. Under the proposed zoning regulations, the unrestricted area would be reduced from 55 per cent of the section to 9.6 per cent, largely concentrated around piers at the southern end. The area devoted exclusively to residential use would be increased from 22 to 44.5 per cent. Retail business structures, with multiple dwellings over stores, would be permitted in 27.1 per cent of the section, and 18.8 per cent would be zoned for regular business structures.

The plan is sponsored by the East Side Chamber of Commerce, and was drawn up on the basis of studies made by that body and the mayor's committee on city planning. These studies were made with WPA labor.

The planning commission can set up the new zoning regulations, after the hearing, simply by passing a resolution. Such a resolution can only be overruled by a three-quarters vote of the city Board of Estimate or by the objection of 20 per cent or more of the landowners in the area affected. Even in the case of such action by landowners, the objection can be overruled by a unanimous vote of the Board of Estimate.

Rehabilitation of this area has already been encouraged by construction of the East River Drive and extension of the Corlears Hook Park. Construction of the limited-dividend Knickerbocker Village housing development a few years ago made a beginning of model housing in the area.



WIND DESTROYS FALSEWORK

A STRONG WIND occurring Feb. 9 wrecked the falsework for the north arch of the Big Creek Bridge on the Monterey San Simeon route of the California State Highway system. This structure, which is being erected in an exposed location on the ocean some 200 miles south of San Francisco, is unusual in that it is to be a bridge without abutments. Soft material on the steep banks made it desirable to cantilever the approach spans as half arches from the same piers that support the main arch spans. The latter, of which there are to be two, will be 177½ ft. each. Construction on the bridge was begun last fall on a contractor's bid of $146,268.

Nebraska Utility Asks Permission to Sell

Testifying before a Federal Power Commission examiner, President Mullison of the Southern Nebraska Power Co., stated Feb. 21 that competition from public power projects is forcing the sale of his company to the Central Nebraska Public Power and Irrigation District. The company, he said, has already lost one large wholesale customer, and several others are now buying on a 90-day basis with the intention of shifting to a publicly owned source of supply in the near future.

President Mullison testified at a hearing on the application of the company for permission to sell its properties to the power district for $898,000.

George Johnson, general manager of the district, testified that the three large power districts now constructing projects in Nebraska with PWA funds "have reason to believe" that they will soon be able to purchase all private utility companies of the state with the exception of the Nebraska Power Co. and the Iowa-Nebraska Light & Power Co. He also said that his district, as a matter of public policy, intends to continuing paying state and local taxes on the properties acquired in order to avoid curtailment of road and school funds.

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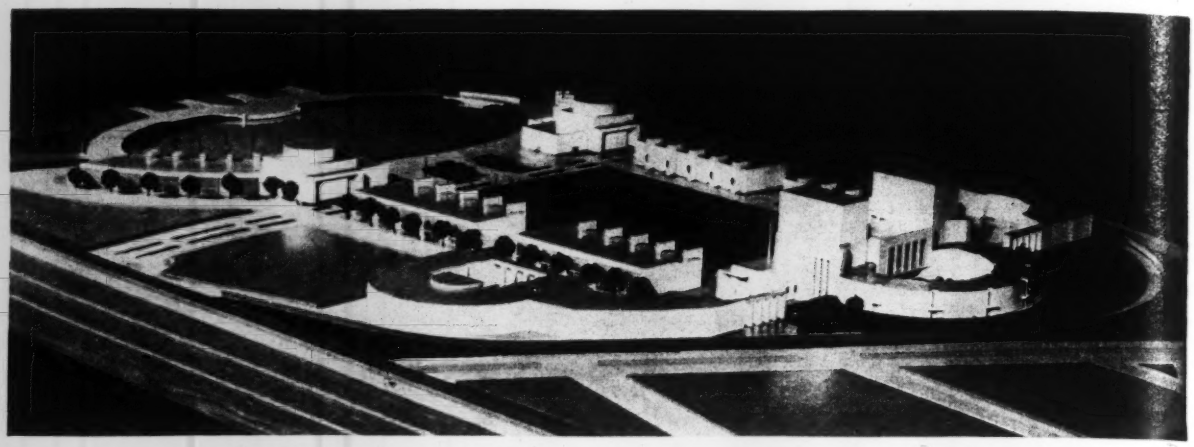


FEDERAL GOVERNMENT TO BUILD THREE MILLION DOLLAR STRUCTURE AT NEW YORK WORLD'S FAIR

MODEL above shows the general nature of the federal government's $3,000,000 exhibit section at the New York World's Fair of 1939. The section will include nine large buildings, a parade ground, and a lagoon. Construction bids are to be invited by the United States New York World's Fair Commission very soon, and it is expected that ground will be broken in the federal area April 1.

The Federal Building at the right above, will cost $940,000 and occupy 282,000 sq.ft. The structure will include two 150-ft. towers 101x50 ft. in plan joined by a center division containing 13 pillars representing the thirteen original states. The building will be devoted to exhibits interpreting the functions of the legislative, executive and judicial branches of the government. Eight other buildings, forming the Hall of Nations, will be grouped around the parade ground and will provide space for official exhibits of many of the foreign countries participating in the Fair.

Seattle Port Bonds Held Illegal

Issuance of the Port of Seattle's proposed $2,300,000 bond issue for a harbor improvement project has been enjoined by the Washington State Supreme Court on the grounds that the program was not officially adopted by the port district and ratified by the voters. The court reversed a decision of the King County Superior Court, which had dismissed a taxpayers suit seeking the injunction against the bond issue.

Two million dollars of the bond issue was to have been expended on a new port unit and the rest on work at Pier 40. The port commissioners adopted a resolution calling for issuance of the bonds without a general vote.

The supreme court in its decision said that a port district must not embark on a comprehensive program of construction without submitting it to the electors. In March, 1930, the Seattle voters adopted a resolution providing in general for a construction program, but the courts held that this resolution was "fatally defective as a comprehensive scheme."

Ulen & Company Will Expand

Stockholders of Ulen & Co. have approved recommendations presented to them that the company expand its construction operations in the domestic field instead of restricting itself to its present foreign practice (*ENR*, Feb. 3, 1938, p. 167).

The stockholders also accepted the recommendation that G. H. Manning, former president of the Stone & Webster Engineering Corp., be made president of the company and Harry A. Arthur chairman of the board.

ENGINEERING CONSTRUCTION CONTRACTS REPORTED BY ENGINEERING NEWS-RECORD, IN FEBRUARY, 1938

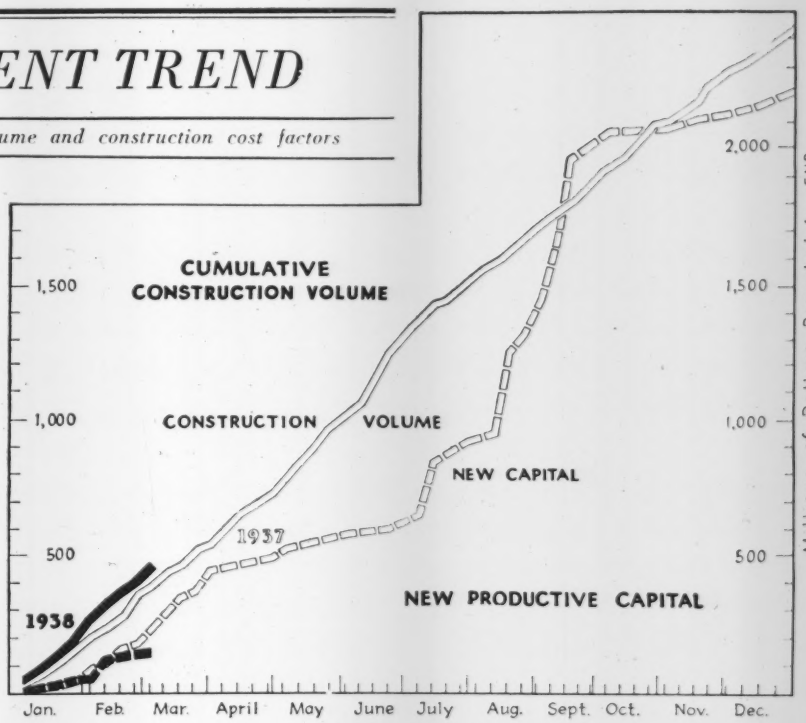
Engineering News-Record *reports projects of the following minimum costs: Water-works, excavation, drainage and irrigation,* $15,000; *other public works,* $25,000; *industrial buildings,* $40,000; *other buildings,* $150,000.

Four Weeks — Thousands of Dollars (000 Omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States February 1938	United States Two Months 1938	United States Two Months 1937	Canada
Public Works										
Waterworks	91	501	126	317	845	166	**2,046**	4,819	19,862	.....
Sewerage	627	1,478	180	3,487	1,422	524	**7,718**	19,854	15,631	74
Bridges, public	51	1,418	83	486	394	730	**3,162**	9,147	19,381	
Earthwork and waterways	314	541	869	292	1,611	38,654	**42,281**	52,567	17,715	
Streets and roads	621	6,389	2,284	9,594	5,100	4,074	**28,062**	56,253	43,168	63
Buildings, public	1,725	16,143	2,374	4,122	6,715	2,907	**33,986**	71,726	50,414	2,073
Unclassified, public	578	1,218	694	280	1,687	1,003	**5,460**	19,068	21,106	260
Total public	**4,007**	**27,688**	**6,610**	**18,578**	**17,774**	**48,058**	**122,715**	**233,434**	**187,277**	**2,470**
Federal government (included in above classifications)	360	1,341	1,298	880	1,798	39,614	**45,291**	58,203	26,716	
Private										
Bridges, private	.....	2,041	.....	.....	.....	.....	**2,041**	2,176	2,112	
Buildings, industrial	622	6,687	337	2,380	5,690	748	**16,464**	43,112	61,662	250
Buildings, commercial	843	54,794	1,543	800	2,924	1,214	**62,118**	108,279	41,172	
Unclassified, private	.....	5,593	128	856	706	180	**7,463**	13,986	70,051	40
Total private	**1,465**	**69,115**	**2,008**	**4,036**	**9,320**	**2,142**	**88,086**	**167,553**	**174,997**	**290**
Total Engineering Construction										
February, 1938 (4 weeks)	**5,472**	**96,803**	**8,618**	**22,614**	**27,094**	**50,200**	**210,801**	.....	.....	2,760
January, 1938 (4 weeks)	6,188	70,603	30,967	25,731	39,153	17,544	**190,186**	.....	.....	4,062
February, 1937 (4 weeks)	6,371	113,350	8,906	24,120	18,197	18,253	**189,197**	.....	.....	5,409
Two months, 1938	11,660	167,406	39,585	48,345	66,247	67,744	.....	400,987	.....	6,822
Two months, 1937	13,125	172,091	39,469	51,352	53,002	33,235	.....	.....	362,274	9,732

THE CURRENT TREND

This week's news of contract volume and construction cost factors



THIS WEEK'S FIGURES

(Thousands of Dollars)

CONTRACTS

	Week Ending Mar. 4 1937	Feb. 24 1938	Mar. 3 1938
Federal	$5,971	$2,437	$4,965
State & Municipal	9,391	22,849	19,076
Total public	$15,362	$25,286	$24,041
Total private	16,763	14,875	20,386
TOTALS	$32,125	$40,161	$44,427

Cumulative
1938 (9 weeks) $445,414
1937 (9 weeks) $394,399

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works $25,000; industrial buildings, $40,000; other buildings, $150,000.

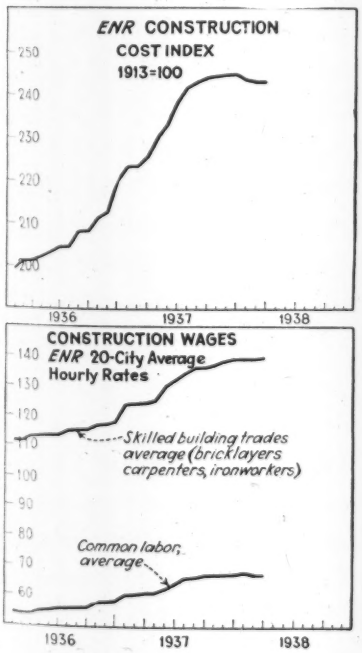
NEW PRODUCTIVE CAPITAL

	Cumulative 1937 9 Wk.	1938 9 Wk.
NON-FEDERAL	$234,827	$148,375
State & mun. bonds.	126,249	72,533†
Corporate securities..	67,703	76,230
PWA loans, grants...	40,868	—2,497†
RFC loans	7	2,109
FEDERAL		
TOTAL CAPITAL	$234,827	$148,375

† Represents transfer from federal to private investment financing through sale by RFC of PWA bonds.

ENR INDEX NUMBERS

COST Base=100	1913	1926	VOLUME	1913	1926
Mar., 1938	243.39	117.00	Feb., 1938	187	82
Feb., 1938	243.39	117.00	Jan., 1938	168	74
Mar., 1937	225.25	108.18	Feb., 1937	181	79
1937 (Av.)	236.41	113.63	1937 (Av.)	171	75
1936 (Av.)	206.41	99.22	1936 (Av.)	185	81
1935 (Av.)	195.22	93.84	1935 (Av.)	135	59



THE MONTH'S SCOREBOARD

CONSTRUCTION VOLUME

(,000 omitted)	February 1937	1938	% Change	Two Months 1937	1938	% Change
Total	$189,197	$210,801	+11	$362,274	$400,987	+11
Private	103,745	88,086	−15	174,997	167,553	− 4
Public	85,452	122,715	+44	187,277	233,434	+24
Federal	14,571	45,291	+211	26,716	58,203	+118

NEW PRODUCTIVE CAPITAL

(,000 omitted)						
Total	$142,924	$85,457	−40	$183,454	$129,856	−29
Private Investment	143,038	88,986	−38	187,629	130,244	−31
Federal (non-fed. wk.)	−114	−3,529	....	−4,175	−388	....

CONSTRUCTION COSTS . . . WAGE RATES . . . PRICES

	March 1937	1938	% Change	Change Feb. to Mar. 1937 Feb.	Mar.	%	1938 Feb.	Mar.	%
ENR Construction Cost Index, 1913 = 100	225.25	243.39	+8.0	223.45	225.25	+0.8	243.39	243.39	0
ENR Building Cost Index, 1913 = 100	188.15	203.89	+8.4	187.95	188.15	+0.1	203.39	203.89	+0.2
ENR 20-CITIES' AVERAGE									
Common Labor	$0.612	$0.675	+10.0	$0.603	$0.612	+1.5	$0.675	$0.675	0
Skilled Labor	1.246	1.396	+12.0	1.244	1.246	+0.2	1.391	1.396	+0.4
Bricklayers	1.319	1.480	+12.0	1.313	1.319	+0.5	1.480	1.480	0
Struct. Ironworkers	1.308	1.448	+11.0	1.308	1.308	0	1.442	1.448	+0.4
Carpenters	1.111	1.263	+14.0	1.111	1.111	0	1.251	1.263	+0.9
Cement, per bbl	$2.54	$2.55	+0.4	$2.54	$2.54	0	$2.54	$2.55	+0.4
Reinforcing steel, new billet	2.78	2.86	+2.8	2.78	2.78	0	2.91	2.86	−1.7
Struct. Steel, Pittsburgh	2.05	2.25	+9.8	2.05	2.05	0	2.25	2.25	0
Sand, per ton	1.17	1.27	+8.6	1.17	1.17	0	1.25	1.27	+1.6
Lumber, 2x4 Fir, per M ft.	36.88	34.15	−7.5	35.88	36.88	+2.7	34.49	34.15	−1.0
Lumber, 2x4 Pine, per M ft.	33.94	29.03	−14.5	33.21	33.94	+2.1	29.09	29.03	−0.2
Brick, common, per M	13.88	14.24	+2.5	13.90	13.88	−0.1	14.24	14.24	0
Ready-mixed Concrete	7.22	7.39	+2.3	7.19	7.22	+0.4	7.39	7.39	0
Struct. Clay Tile, 3x12x12	74.08	74.55	+0.6	74.08	74.08	0	74.55	74.55	0
Paving Asphalt, cars, ton	17.16	16.40	−4.4	17.11	17.16	+0.3	16.84	16.40	−2.7

MATERIAL SHIPMENTS . . . BUILDING PERMITS

	February 1937	1938	% Change	Jan. 1938	% Change Jan.-Feb.
Steel A.I.S.I. (% operating capacity.)	81.1	30.7	−62.0	29.0	+ 6.0
	January 1937	1938	% Change	Dec. 1937	% Change Dec.-Jan.
Fabricated Struct. Steel, (A.I.S.C.)* tons	99,934	86,421	−13.6	108,396	−20.4
Cement, Thous. bbl., (U.S. of M.)	4,689	4,390	−6.3	4,793	−8.3
Building Permits, Dun & Bradstreet, (,000 omitted.)	$68,543	$146,850	+114.2	$118,716	+23.7

* Subject to revision.

RENT INDEX

	January 1937	1938	% Change	Dec. 1937	% Change
Rent (housing) Index, N.I.C.B.	82.2	88.2	+7.0	88.7	−0.6

Column Formula Changes Proposed by A.C.I.

Mass concrete, columns, rigid frames are highlight subjects at Chicago meeting of American Concrete Institute

Mass concrete, eccentrically loaded columns and rigid frame bridges were highlight subjects at the annual meeting of the American Concrete Institute, in Chicago, Feb. 22-24. The first session of the meeting was given over entirely to mass concrete, and in the second session, recommendations for changes in eccentrically loaded column formulas were made, based on tests reviewed there. Satisfactory agreement between theory and practice in rigid-frame bridge work was reported in the closing session.

The institute reports that it is headed back to pre-depression strength, and a large convention attendance reflected this fact, more than 600 members and guests being registered.

The symposium on mass concrete presented a well-rounded program covering present knowledge in this field. J. W. Kelly, associate research engineer, University of California, led the program with a description of temperature investigation of mass concrete. He presented the conclusion, supported in subsequent papers, that a low casting temperature is desirable to hold down thermal stresses. F. R. McMillan, director of research, Portland Cement Association, Chicago, presented a report of a field survey of the condition of large dams, beginning with Crystal Springs dam, built in the '80s, and including Elephant Butte, Pine Canyon and Norris dams, the latter completed only two years ago. The results of this survey emphasized the effectiveness of present methods of dealing with the stresses produced by cooling from the high temperatures that result from rapid placing and the use of rapid-hardening cement.

Causes of cracking in mass concrete and some data on amount of cracking of dams were given by R. F. Blanks of the U. S. Bureau of Reclamation, Denver. Comparing effects of different heights of lift, different cements, etc., Prof. Roy W. Carlson, Massachusetts Institute of Technology, Cambridge, brought out further facts concerning temperatures, stresses and strains in mass concrete.

In the afternoon session, following the mass concrete symposium, twelve open committee "confabs" were called, with a view to placing the discussion of committee problems on a broader basis.

In the Tuesday evening session, after a talk on the principles of shell dome design by E. C. Molke, of Roberts & Schaefer Co., Chicago, Prof. Frank E. Richart, University of Illinois, Urbana, reported the results of recent tests made on eccentrically loaded columns and indicated how present design formulas should be modified to conform to the test results. In line with this suggestion, Prof. R. R. Zipprodt, Columbia University, New York, secretary of the building code committee, reported the committee's proposal of a modified column formula in the form suggested by Prof. Richart.

An investigation of rigid-frame bridges made at the University of Illinois in cooperation with the Portland Cement Association, was reported by Prof. Wilbur M. Wilson, and Ralph W. Kluge, University of Illinois. The tests, on 48-ft. spans, showed that present design practice is safe but that shear reinforcement should be provided.

Wednesday afternoon various projects in concrete were described. C. A. Bullen, of W. S. Bellows Construction Co., Houston, Tex., dealt with problems met in building the 570-ft. San Jacinto Memorial, and John J. Earley, Washington, D. C., told of work on the Edison Memorial Tower at Menlo Park, N. J. The lightweight concrete pavement which was used to save the builders of the San Francisco Bay Bridge three million dollars was described by Glenn B. Woodruff, engineer of design on that job. R. F. Blanks and E. N. Vidal of U. S. Bureau of Reclamation, Denver, reported out of committee recommended practices in design of concrete mixes.

At the Institute's annual dinner addresses were made by Frank T. Sheets, president of Portland Cement Association and William J. Cameron, of the Ford Motor Co.

Other papers dealt with sulphate action on cement, mortar and concrete, one by Thomas E. Stanton, Jr. and Lester C. Meder, both of the California Division of Highways, and one by T. Thorvaldson, University of Saskatchewan, Saskatoon, and D. W. Wolochow, National Research Council of Canada, Ottawa. D. G. Miller, U. S. Department of Agriculture, St. Paul, presented results of studies of concrete silo staves, and H. S. Meissner and S. E. Smith of the Bureau of Reclamation, Denver, gave a paper on concrete curing compounds.

Indeterminate analysis and reinforced concrete design shared the final session with the rigid frame bridge paper. Prof. George A. Maney, Northwestern University, Evanston, offered a simplified computation procedure for indeterminate frames. Albert Smith, of Smith & Brown, Chicago, presented some conclusions on unsettled points of design on the basis of a group discussion by twenty Chicago engineers.

John J. Earley was elected president of the institute for the ensuing year; Prof. F. E. Richart and R. B. Young, testing engineer, Hydro Electric Power Commission of Ontario, were elected vice-presidents.

It was decided by the board of directors to expand the work of the institute by giving more attention to construction problems, particularly those of small-sized construction. A regional meeting to be held in Detroit later in the year was proposed and tentatively adopted.

• • •

Time Extension Asked On Materials Study

The Bureau of Standards is asking an extension of the time allowed for its housing and building materials investigation from the original two years to three years. It is pointed out that the $300,000 originally asked has been cut by Congress to $198,000 and that the task can not be finished with that sum within the original time limit.

Dr. H. L. Dryden, in charge of coordinating the work of the bureau with industry, reports that there are two general types of technical problems upon which the bureau is engaged. One type relates to difficulties encountered in constructing governmental buildings, and the second relates to problems arising in connection with the work of the Federal Housing Administration and similar organizations, lending money on construction. These bodies are being flooded with suggestions for new types of construction, some proposing entirely new materials or combinations of materials new in housing construction for which there is no service experience. The bureau is now busily testing many of these materials for service in walls, roofs, floors partitions and other housing elements.

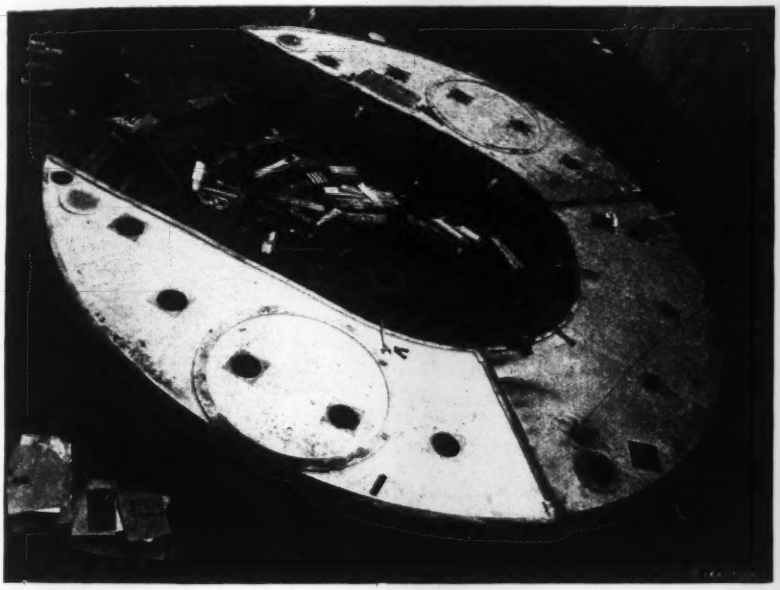
Among the tests the Bureau is making for floor materials are examinations of the structural properties of completed flooring, including steel joist, sheet metal, and steel plate flooring fabricated by welding. Tests are also being made of the structural properties of other materials.

Engineer Asked to Prepare Chicago Traction Plan

Because the various interests involved in the reorganization, rehabilitation, and consolidation of the traction properties in Chicago have not been able to come to any agreement, federal judge Wilkerson, has appointed Walter H. Shaw, consulting engineer, to prepare a centralized plan by April 5.

Mr. Shaw was instructed to consult with the surface, elevated and bus interests as well as the city and state agencies which will have to approve a franchise. If he cannot bring about agreement he is to present to the court the outline of a plan and a proposed franchise ordinance. Since the surface and elevated companies are both before Judge Wilkerson under receivership, the court is in a position to conclude bankruptcy proceedings and enter a decree if no agreement can be reached.

The city has reduced to 30 days the usual 90-day extension of the franchise which expired in 1927 for the Surface Lines. The plan for consolidated service proposed in the report to the city by Philip Harrington, traction engineer, (*ENR*, Oct. 28, 1937, p. 694) will be available to Mr. Shaw.



MACHINING WORLD'S LARGEST BEARING

BELIEVED to be the largest journal bearing ever made, the 317,000-pound horseshoe bearing which will carry the million-pound load of the world's largest telescope at Mt. Palomar, California, is shown being machined.

During machining the horseshoe is bent out of shape while its surface is machined so that it will be squeezed back into an arc of a circle under the weight of the telescope mounting. The bearing is 46 feet across and 53 inches thick. Because of its unusual size, it had to be made in three sections so that it could be shipped on flat cars.

The work of pulling and pushing the hollow steel frame out of its circular line is done before it is turned on a specially constructed boring mill. Near the bottom of the "U" a large compression member pushes outward while the top of the bearing is pulled in by steel bolts with turn buckles.

When hoisted into position on a steel base at the telescope site, the bearing will rest on two steel oil pads through which oil will be pumped at a pressure of 250 pounds per square inch.

Designers of the telescope support selected the horseshoe shape bearing to enable the 60-foot telescope tube, housing the 200-inch reflecting mirror, to swing easily between the sides of the horseshoe for an unobstructed view from the polar to the southern horizons. The ability of the bearing to turn freely on its oil pads will permit the tube to be sighted from the eastern to the western horizons.

The telescope tube, a welded steel box structure, will swing between two 60-foot steel tubular arms forming a yoke. The upper end of the yoke will be welded to the horseshoe and a flat swivel at the lower end will turn on a ball and socket bearing floating on oil. The yoke will be hung equatorially parallel to the earth's axis, or at an angle of slightly more than 33 degrees which is the latitude at Mt. Palomar.

Plan Larger Locks For Panama

Washington Correspondence

The work of investigating the possibilities of increasing the capacity of the Panama Canal is moving slowly, as only a small force in available.

When additional locks are built, indications now are that, although they will be in parallel with the exsiting locks, they will be located some distance away. The approach would be through auxiliary channels. It is possible that this would decrease the chance of airplane bomb damage.

If and when the new locks are built, their minimum dimensions probably will be 1250 by 125 feet, with a depth of 45 feet over the sills. The usable length of the present locks is 1000 feet, and the width is 110 feet with a depth of 40 feet over the mitre sills. With the possible exception of the Queen Mary and the Normandie, any ships afloat can pass through the present locks.

On a strictly commercial basis, authorities feel, it will be a long time before a canal across Nicaragua would pay. The present canal can handle all commercial traffic likely to be offered during the next twenty years. But this is none too long, it is pointed out, to prepare plans, get the necessary legislation and do the construction.

While the construction of new locks at the Panama would be the more economical means of accommodating increasing commercial traffic, the President holds that the present canal is vulnerable to air attack.

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Moore Leaves Engineers To Take Brigade

Col. Richard C. Moore, commanding engineer of the Second Engineers, and until recently division engineer, Missouri River Division, Corps of Engineers, at Kansas City, has been nominated by the President as a brigadier general of the line to succeed Brig. Gen. James A. Woodruff now commanding the Hawaiian Coast Artillery Brigade.

Col. Moore is one of the most widely known officers of the Corps of Engineers. For the past seven years he has been on Mississippi and Missouri river work. Previous to that he was in the office of the Chief of Engineers for four years and on the military mission to Peru. During the World War he had charge of all railway construction behind the Second Army.

Unusual Labor Set-Up On Water Tunnel

Industrial unionism found successful on Loch Raven-Montebello tunnel construction

A year ago when the J. F. Shea Company of Los Angeles started work on the Loch Raven-Montebello water tunnel for the city of Baltimore, a type of labor organization new to the heavy construction field was set up on the project. For the first time in the East a tunnel was organized on a job basis rather than by crafts. An editor of *Engineering News-Record* recently visited the tunnel and found that after a year's trial the labor relations were satisfactory to all concerned—the contractor, the engineers and the workmen.

All workers on the tunnel up through the shift bosses are members of Local 273 of the tunnel department of the C.I.O. International Union of Mine, Mill and Smelter Workers. The local was organized by John V. Carter, who is now its business manager and acts as Eastern Tunnel Director for C.I.O. Membership is about 500, all working on the Montebello project.

The union exists on the job through an informal agreement between Carter and the contractor. No written agreement was signed by either party and the contractor reserved the right to dispense with the union's services at any time. However, the labor relations have been so satisfactory that unless something unforeseen happens the job will be carried through to completion under the present arrangement. To the outside observer there is an amazing spirit of cooperation on both sides.

Labor's demands are few

Under the arrangement the demands of labor are few and simple. All personnel, except certain clerical and supervisory forces, must be secured through the union. Even though the contractor may want to hire a specific person, that person must apply through the union and wait his turn for employment, though it is usually arranged that he be taken on within a short time. Any workman may be fired for insubordination or incompetency without interference by the union. However, as Carter points out, the shift bosses who are responsible for most of the hiring and firing, are members of the union, and naturally they won't tolerate insubordination nor will they condone inefficiency. When it comes to layoffs because of slackening off of work, efficiency and capability alone of the individuals are considered. There is no such thing as seniority, except that men laid off apply to the union for re-employment, and are assigned in order of registration when men are called for.

Minimum wage rates for various classes of work were established by terms of the construction contract. The wage rates agreed upon by the union and the contractor are slightly higher than the contract requirements, and many of the classifications have been consolidated. Yet some differentials in skilled classifications still exist, though the union's ultimate goal is for one rate for skilled workmen, another for semi-skilled, a third for unskilled and a fourth (minimum) for junior clerical and foremen classes. A 40-hr. week prevails.

No craft lines

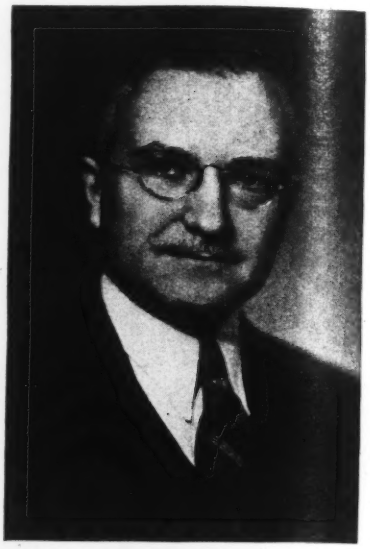
Craft distinctions do not exist. As long as a man works in the same group of operations paying the scale at which he was hired, he can be shifted about as needed. If he is needed on a higher-wage operation, he can be so employed provided he is paid the higher scale, though temporary transfers of only a few hours are usually overlooked. A workman can be transferred to a lower-pay task temporarily without changing his pay. If necessary to make the change permanent because of lack of work in the higher-pay operations or because of incompetence of the individual, he is given the chance to work at the lower rate.

Because the men can be switched from one task to another the contractor can build up an all-around crew of minimum size. The workmen under this system can count on a substantial continuity of employment, for as one type of operations slackens off another usually picks up. A capable mechanic or laborer can usually stay with the gang regardless of the work being done. Many individuals have been trained on the job and have stepped into better paying positions on the project.

Minimum crews

The employer benefits from the minimum crew requirements. For example, all electric current for the job is being generated at the shafts by diesel-driven generators. In the same houses are diesel-driven air compressors and electric-drive ventilating fans. One man per shift at each shaft operates and maintains all this plant. Under the craft system the contractor would be required to hire a diesel man, a compressor operator, a ventilating man, and helpers and oilers besides.

Dues for each member, regardless of pay, are $10 for initiation and $5 per month. Cards are good for transfer to other C.I.O. locals without further payment for initiation. The local pays $100 death benefits, pays sickness benefits, and provides loans to members for worthy cause. There is no deduction from wages for union dues; the business manager collects direct from the workmen. Mr. Carter explains that the rate of dues, the maximum allowed under C.I.O. regulations, was voted by the membership to finance a campaign to organize other jobs and future work.



Lacher Named Secretary Of Railway Engineers

Walter S. Lacher, engineering editor of *Railway Age* and managing editor of *Railway Engineering and Maintenance*, has been named secretary of the American Railway Engineering Association to succeed E. H. Fritch. Mr. Fritch retired as secretary of the association last March after 38 years of service. Frank McNellis, assistant secretary, has been serving as secretary since Mr. Fritch's retirement. The new secretary will take up his duties when officers are installed at the close of the annual convention March 15–17.

Mr. Lacher was born in Winona, Minn., in 1884 and graduated from the University of Wisconsin in 1907. He began railroad work in the engineering department of the Chicago & Alton before completing his college course and returned to that road for two years following graduation. Subsequently he was with the Illinois highway department and with the bridge department of the C. M. & St. P. Ry. In 1915 he joined the staff of *Railway Age* and in 1931 was appointed engineering editor.

Neal D. Howard, eastern engineering editor of *Railway Age* at New York, succeeds Mr. Lacher at Chicago and Merwin H. Dick from the Chicago office succeeds Mr. Howard.

LABOR NOTES

THE THREAT of a general strike on federal jobs in the St. Louis area (*ENR*, Feb. 24, 1938, p. 287) was averted by a partial victory for the common laborers union. The U.S. engineers shut down work on clearing operations above the Alton Dam in the Mississippi River, which had been picketed by unions demanding a 67½ cent an hour wage rate instead of the 44 to 50 cents being paid on the job. The union was successful in obtaining a 90-cent an hour wage scale on the $175,000 levee-strengthening project south of East St. Louis; a further demand of the union for a 40-hour week is being arbitrated by the East St. Louis Labor Mediation Board. In view of these developments, the St. Louis Building Trades Council decided at a special meeting Feb. 21 that it would not be necessary to call a general strike. Orders for walk-outs on all federal jobs had gone out before the meeting but they were immediately recalled.

A.F.L. ORGANIZERS attempting to organize maintenance crews of the Washington State Highway Department met late last month with highway director Murrow to ask that highway employees doing maintenance work on roads be paid the same wages as union men working on contractors' construction gangs. Mr. Murrow said that he was unable to act, since salaries are fixed by the legislature.

C.I.O. ACTIVITY on heavy construction in the East was foreshadowed in Pittsburgh Feb. 21 when C.I.O. organizer Federoff demanded that members of the new C.I.O. laborers union there be given a share in the work on the Crooked Creek and Tionesta dam projects and on highway work in Pennsylvania.

THE FEDERATION of Architects, Engineers, Chemists and Technicians, C.I.O., has been certified by the National Labor Relations Board as sole bargaining agency for 20 miscellaneous laboratory employees of the U. S. Testing Co., Inc., Hoboken, N.J.

THE F.A.E.C.T. expanded in another direction when it announced the issuance of a charter to marine draftsmen in the Philadelphia navy yard. President Berne of the federation announced that an organizational drive had been started among the 3,000 technical employees of the federal navy yards.

Straus Denies Deferring Slum Removal

Nathan Straus, Administrator of the U. S. Housing Authority, has issued a statement denying press reports that slum clearance phases of the federal housing program are being postponed (*ENR*, Feb. 24, 1938, p. 286). He also denied that no satisfactory application for housing projects had been received.

Mr. Straus said that of a number of applications now before the authority, more than half are for slum clearance projects with the new housing to be done on the site of old slums. "In all the other proposed projects," he said, "where it is not feasible, in the judgment of the locality concerned, to do the new building on the old slum site, slum units equivalent in number to the new dwelling units proposed will be eliminated or demolished . . . Slum clearance and the rehousing of slum dwellers are proceeding hand in hand."

Roof of Vehicle Tunnel Fails at Chattanooga

A section of the brick ceiling of the McCallie Ave. tunnel in Chattanooga, Tenn., fell the morning of Feb. 20. A 4x6 ft. section dropped from the crown of the arch near the center of the tunnel, and subsequent examination showed that cracking and movement of the lining in the vicinity required immediate strengthening of the tunnel lining for a distance of 200 ft. on each side of the failure. No one was injured when the ceiling fell.

The McCallie Ave. tunnel, a vehicle tunnel built in 1910, is 931 ft. long. In section it consists of a 13-ft. radius semi-circular brick arch with 6-ft. sidewalls. It carries a 26-ft. roadway and a 4-ft. sidewalk on one side. The arch is 2 ft. thick. The tunnel was built through soft ground.

County engineer E. M. Murrell attributes the failure to structural weakness arising from improper design and construction.

The McCallie Ave. tunnel, although entirely surrounded by the city of Chattanooga, is owned by the county, since it was built before the city spread out around it. The city has consistently refused to take jurisdiction over this tunnel.

Senate Restores Gilbertsville Dam

Provides $2,763,000 to start dam after House had dropped the item from its bill

In approving the independent offices appropriation bill carrying funds for the fiscal year beginning next July 1, the Senate on Feb. 25 approved the start of construction on Gilbertsville dam by the Tennessee Valley Authority. It also increased the amount granted to the Rural Electrification Administration for construction loans from $30,000,000 to $40,000,000. The bill was then sent to a conference committee to reconcile this and other differances between the Senate-approved measure and that already passed by the House. (*ENR*, Jan. 20, 1938, p. 94)

The Gilbertsville item of $2,763,000 was opposed by Sen. Vandenberg of Michigan, who maintained that the proposal should receive further study before being authorized, and by Sen. Miller of Arkansas, who objected to its construction without local contribution of land and flowage rights, as required of other flood control measures. The debate revealed string sentiment within the Senate for the abandonment of this requirement as respects all flood control reservoirs. The project was defended by Senators McKellar of Tennessee, Hill of Alabama, and Norris of Nebraska.

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WPA Aid Is Asked To Rebuild Dam

The county commissioners of Wyandotte county, Kansas, have applied to the WPA for a federal grant to aid in rebuilding the Wyandotte County Lake Dam which failed last September.

Robert E. McDonnell of the Kansas City firm of Burns & McDonnell has reported that it will cost $1,874,000 to rebuild the dam according to the recommendations of the board of engineers who studied the failure (*ENR*, Feb. 24, 1938, p. 281). Mr. McDonnell was retained by the county commissioners to prepare an estimate of the cost after the board had made its report. The original cost of the dam was a little over $900,000.

Mr. McDonnell said that his estimate was based on the use of a maximum amount of WPA labor. In addition to labor costs, $343,500 was allowed for clearing the downstream side of the present dam to bedrock, $553,000 for dredging sand from the Missouri River, and $324,000 for borrow pit work to obtain additional material from the dam.

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Fiber Water Pipe

Sir: Some twelve years ago tests were conducted in the University of Pennsylvania civil engineering laboratories on Italite pipe, a cement-asbestos product made in Genoa, Italy, the results of which were published in the Jan. 28, 1926 (p. 169) issue of the Engineering News-Record. This pipe is now being manufactured and marketed under the name of Transite pipe.

This laboratory recently completed tests on another newcomer in the field of water pipes—this time, a fiber conduit which seems to have many virtues. Test results (see Fig. 1) show this pipe to have a coefficient of $C = 150$ in Williams and Hazen's formula, and a value of $n = 0.0084$, the coefficient of roughness in Kutters formula for $S = 0.01$, and a value of $n = 0.0086$ in Manning's formula.

These tests indicate a very smooth pipe with high capacity characteristics and since it cannot tuberculate it should not fall off in capacity with the passing of time. It is a non-conductor and therefore not subject to electrolysis. The material can be cut with a hacksaw, machined on a lathe, tapped for service connections, and is very light and easily erected. The joints are made with machined tapered sleeves which, in the test, were tight under 10 and 50 ft. heads.

This project has been used for some time for electric power conduits under the name of Fibre Conduit.

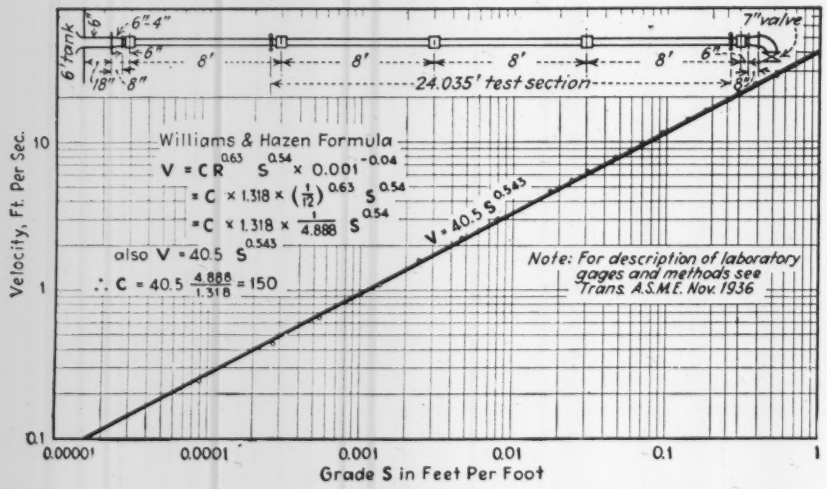
W. S. PARDOE
Professor of Hydraulic Engineering
University of Pennsylvania
Philadelphia, Jan. 26, 1938

Highway Location *au Rhum*

Sir: Here is a highway layout which I came across in trying to re-establish a lost or uncertain highway line. How times have changed—*NO RHUM* allowed during working hours today. The quotation is from the Kent Connecticut Land Records, Vol. 2, p. 623, dated April 28, 1757 and recorded Dec. 15, 1759. This description is for a road in Warren formerly a part of Kent.

Beginning at a white pole marked on ye bank of Shepaug River about forty rods up ye stream above ye chroch of ye River by a small falls in ye River where John Davis set his Elle pot where we drank a bottle of *Rhum* and from sd white oak pole we run on ye East side of ye highway up stream of sd River four Rods wide joyning upon ye River one hundred and fourteen Rods to black oak pole and stones thence
N. 19 W. 36 rods, to ye southwest corner of John Davis pitch, thence Northwesterly 32 rods, 3 rods wide to another of John Davis corners, thence North 26-00 S. 18 rods, thence N. 27-00 E. 10 rods, then N. 31 E. 36 rods, thence N. 14 rods, to ye east line of ye 6th lot in the fourth Denition, thence North 38° E. 54 rods to a heap of stones in the East line [illegible] 7th lot in ye fourth Denition [illegible] every turn in sd highway there is [illegible] of stones and bounds.

RUSSELL P. McC[illegible]TH
Connecticut State Highway Dep[illegible]
New Milford, Conn., Feb. [illegible]



Hydraulic characteristics of 4 in. fiber conduit recently tested at the University of Pennsylvania

Influence Lines

Sir: Mr. Kruys' article, entitled "Influence Lines by Moment Distribution", in your issue of Ja[illegible] 20, clearly explains in detail an extremely practical application of the Cross method of moment distribution.

Mr. E. C. Hartmann and Mr. G. M. Dillingham, in discussions of Prof. Cross' paper, "Analysis of Continuous Frames by Distributing Fixed-End Moments", 1932 *Transactions*, Am. Soc. C. Eng., pages 93 and 125, respectively, outline procedures substantially identical with Mr. Kruys' article. Cross and Morgan's "Continuous Frames of Reinforced Concrete", (Wiley, 1932), and Vol. II of Grinter's "Theory of Modern Steel Structures", (Macmillan, 1937), also mention this application of moment distribution.

Both of the latter two books suggest distributing the unit moment only once for each joint as does Mr. Kruys. However, they suggest distributing an *unbalanced moment at each joint*, rather than a fixed-end moment at the end of each member. In the particular case of finding influence lines for moments at the joints, the same amount of work is involved for either case.

When once this unit moment at each joint has been distributed, it is then possible to obtain the combined effect of load systems acting simultaneously in various spans without recourse to influence lines. Considering that an influence line should be found for the moment at each joint, at least, the variation of dispensing with influence lines, and using instead the "influence values", (Grinter's terminology), may produce some saving of time. The writer's experience shows that it has in certain cases. A numerical example showing the distribution of an unbalanced moment at the various joints is given in Cross and Morgan's book. This example, regardless of which procedure is preferred, illustrates the advantage of first distributing a unit moment at some joint near the center of the structure, and holding this joint

locked against rotation when distributing unit moments at other joints. Since the moments distributed to all joints from a unit moment at this joint are already known, the moment induced at this joint when locked can be distributed throughout the structure by proportion without further balancing by moment distribution.

Attention is called to the change in sign convention in Mr. Kruys' Tables I and II. The writer finds it more convenient to retain throughout all computations the same sign convention as used in distributing the unit moments, and then as a last step, if necessary, transfer the moments at the ends of members into the conventional continuous beam or frame moments.

Mention of previous explanations of this application is not to be taken as criticism of Mr. Kruys' article. Rather, the fact that the application has been found to be a workable one by several engineers should serve to emphasize the value of once more bringing it to the attention of the civil engineering profession.

LEWIS K. OESTERLING
Chicago, Illinois, Feb. 7, 1938

Asphalt Residue Test

Sir: In *Engineering News-Record*, Jan. 13, 1938, p. 79, an article by Frank E. Kinsman describes a method of testing asphaltic residues involving the automatic removal of these residues from the heating source. Such a method was developed by our laboratory a number of years ago; is described in our technical bulletin No. 8, and is protected by U. S. Patent 1,967,424, assigned to the Socony-Vacuum Oil Co., Inc.

We believe that this automatic method of running this test is very superior and our equipment, in use for a number of years, has given us far more satisfactory results than can be duplicated. We do think that the use of an electric heater automatically shut off when the desired residue amount has been obtained and the elimination of circulation uncertainties by the use of a fan, all as described in our technical bulletin, are desirable improvements over the method shown. We have found no difficulties in keeping the temperature constant without much attention just as commented on by Mr. Kinsman in his type of heater.

We are glad to supply the technical bulletin describing the apparatus to those interested who will write for it, and might comment that the primary purpose of obtaining a patent which covers the method described is not to prevent its use, but to make sure that the idea is kept open to such use under satisfactory conditions.

H. G. NEVITT
Manager Asphalt Department, Socony-Vacuum Oil Co., Inc. Kansas City, Mo., Jan. 18, 1938

Tremie Concrete?

Sir: What is the desirable consistency of tremie concrete? I have heard varied discussions—some in favor of dry concrete—others in favor of wet concrete. Perhaps some of your subscribers would like to express their opinions.

J. DICKSON ROOTS
Norwood, New Jersey, Feb. 15, 1938

Construction Expenditures

Sir: May I be permitted to comment on the letter from Daniel C. Drucker, in your Jan. 27 issue, p. 133, relative to my article on "Construction and National Income." Mr. Drucker confirms, by his letter, my assertion that there is no general agreement on what the actual factor is that represents secondary spending.

Mr. Drucker indicates his belief that my assumption that there may be $1.50 to $2.00 of secondary spending for every $1.00 of primary is too high. He works out a multiplying factor of from 1½ to 2 to represent the total primary and secondary employment and states that "These ratios are more in accordance with those used by economists" and cites the English Economist Keynes as putting it at 2 or less.

Prior to writing my article I had studied five different articles on this subject by economists in which they sought to appraise this "multiplier" as Keynes calls it. Most of them were basing their estimates on English conditions and indicated the "multiplier" would be higher in America. Their "multipliers" varied from 1-2/3 to more than 3.

J. M. Clark in his 1935 Report to the National Planning Board writes, "It is interesting to note that Keynes, with these considerations in mind, has estimated the leakage for the United States at one-third, in a paper delivered after the present writer had independently made the same estimate." This means that, at each re-spending, two thirds of the amount received are spent which will build up a total of $2.00 of secondary expenditures for each $1.00 of primary. This means a "multiplier" of 3 to represent the total of primary plus all secondaries. This conforms to my maximum assumption of 2 to 1 for secondaries, my alternative assumption of 1½ to 1 being more conservative.

My two assumptions, therefore, lie within the range of estimates noted first above, going neither as low as the lowest nor as high as the highest and further appear to be confirmed as reasonable by the above quotation from J. M. Clark's report and the diagrams which illustrate it.

As further evidence that my assumption is reasonable, Gerhard Colm of the New School of Social Research, in an article in the May 1936 issue of *Social Research* develops his study of the probable effect of the federal pump-priming expenditures on two assumptions as to the magnitude of secondary repercussions, viz. 1. to 1, and 1. to 1 at the start increasing to 2 to 1 as business began to revive.

I entirely agree with Mr. Drucker that while the construction industry is vitally important, its effect should not be overestimated. I feel the economists above quoted tend to show that my assumptions are reasonably conservative. An accurate understanding of its importance is greatly to be desired and if any one has better evidence than I have cited, that indicates my estimate is excessive, I trust he will submit it.

Since writing my article I have come to believe that the construction industry is the largest, not the second largest, at least in periods of prosperity. Two economists have told me that it is larger than agriculture according to the current Department of Commerce estimates. It becomes, therefore, still more important that we should appraise as accurately as possible its significance as a prime factor in the national income.

WILLIAM STANLEY PARKER
Architect
Boston, Mass., Feb. 18, 1938

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MARCH 3, 1938

ON ALL SIDES the statement is heard that there would be a revival of business if building costs would come down. This statement immediately raises question as to what keeps labor costs high. A complete answer is difficult to make, but one fact stands out. A large part of the responsibility rests on those who set "prevailing-rate" schedules under the laws now on many statute books. Take New York state as a conspicuous example. Millions of dollars' worth of work has been held up and many millions more are imperiled because of the ridiculously high rates set by the state department of labor, rates that are far above actually prevailing rates. The same is true elsewhere. These agencies should be asked to state publicly how they arrived at such high figures. Turning on the spotlight might make them more conscious of their public responsibility.

Cracking in Dams

PROGRESSIVE EVOLUTION of practice was responsible for the most important development discussed at the American Concrete Institute meeting last week, the improvement of mass concrete construction to check the formation of cracks by contraction as the concrete cools from excessive setting heat. A symposium of papers made available for the first time a wide range of information on this troublesome phenomenon. In particular a summary of experience with reclamation dams and a report on the condition of a number of large dams up to fifty years old are permanent records of facts that promise to have long-time effect on practical procedure. Milestones in the evolution of practice are the Crystal Springs Dam, built back in the '80s of slow-hardening cement, dry-tamped concrete and block construction — a thoroughly sound structure today; the Elephant Butte and Arrowrock Dams, protected from serious cracking troubles by the low active content of the sand cement used in building them; and Boulder Dam, with its low-heat cement, grouted contraction joints and circulation cooling. As an indication that accepted beliefs are not always beyond question it may be noted that the use of an interground mixture of sand and cement, sharply opposed when it was adopted more than twenty years ago, is now endorsed by the test of time. Perhaps further experience will similarly change some present views on mass concrete. In the main, however, they are likely to stand as fundamentals of good practice.

Structural Complexities

LARGE-SCALE EXPERIMENT made an achievement only second to the evolution of mass concrete practice, in the tests of concrete rigid frames carried out by W. M. Wilson at Illinois, also reported at the A.C.I. meeting. It showed, as might have been expected, that the interaction of material and load in such a structure involves many complexities; variation of the rigidity of the concrete causes the structure to behave rather differently from the assumptions, and the formation of minute stress cracks has even greater influence. Nevertheless the tests are reassuring by showing that the resistance of the structure as a whole is not seriously affected by variations of this kind, and that the customary methods of design are safe. The designer may well take note of the fact that the form of the test frames corresponded to the end-hinged condition, and that for this reason the attempt to make them act as fixed-end arches was not very successful. More serious than this, however, was the fact that the arch failed in shear at very low stress, about 70 lb. per sq. in. As failure did not occur until five times the designed live load has been applied the frames displayed remarkably high safety in respect to bending action, but the low shearing strength gives warning that ordinary rules governing the omission of shear reinforcement may be dangerous when applied to such structures.

Water in the Desert

THERE is little likelihood that the pioneer settlers of the Southwest had any intimate contact with the natives of Baluchistan, India, yet there is a striking similarity in their approach to the problem of water supply. In the semi-arid regions of the Southwest an ingenious scheme was developed for storing water: a dam would be thrown across a dry gorge, which floods later filled with gravel and sand; all rainfall that then percolated into the ground and found its way into the gorge would be stored in the pores of this filling, protected from evaporation. These "desert tanks" furnished a reliable supply of water during the dry season. In far-off India on the Baluchistan plateau, as in other desert regions, nature provided these debris-filled "tanks" at the base of hills, and during the season of melting snow they fill with water. As described in

this issue the natives of the region display uncanny skill in tapping these underground basins and diverting the flow for irrigation purposes. Their method of digging tunnels from the underground water storage to cultivated areas many miles away with only the most primitive equipment is of special interest because of their instinctive ability to maintain line and grade. Few practices of modern engineering display greater ingenuity in their solution than the development of desert tanks and Indian karezes.

A New Labor System

LABOR ORGANIZATION of a type new to heavy construction has been in successful operation on the Baltimore water tunnel for a year past. The tunnel men are combined in an industrial union in which all employees rate as tunnel workers and not as craftsmen of this or that special kind. The system contrasts sharply with the craft unionism that prevails in building work and is now seeking to enter heavy construction.

Under the Baltimore plan any workman can be put to another kind of work within his capabilities. The employer gains flexibility and efficiency and avoids delay; the worker gains a continuity of employment not attained under the craft system, since he is not out of a job when one particular operation comes to a stop. The drill runner or pipe man may turn to form building, the mucker to track work, without interruption of employment.

By permitting the use of workmen at any task they are capable of performing, the system furthers the training of skilled mechanics and thus aids in relieving the potential shortage of experienced construction labor. It also offers the opportunity of discovering hidden talent which construction will need in the near future.

The plan effectively does away with some of the difficulties of craft union operation in heavy construction. An all-around working force of minimum size can be built up and kept in action, and the job does not have to be loaded unnecessarily with high-priced mechanics who work only a small part of the time. Jurisdictional troubles vanish, for there are no jurisdictions.

One reason for the success of the system at Baltimore is the presence of an energetic and fair-minded manager at the head of the union and the realization of all parties that both labor and employer have a stake in the success of the project. Under other conditions the system might not prove as satisfactory. Nevertheless its record to date makes it well worth study by labor and contractors alike. It may show the way to labor relations that will stabilize construction, bring down costs and reduce discontinuity of employment.

Partners in Progress

DURING recent years the problems of everyday concrete practice have been somewhat neglected in technical discussion. Overshadowed by matters of research and design, the craftsman's work received cursory attention at best, which is hardly a sound condition in view of the fact that theory and practice are necessary partners in the progress of every art. The decision of the American Concrete Institute to reestablish this partnership represents a constructive return to the normal relationship.

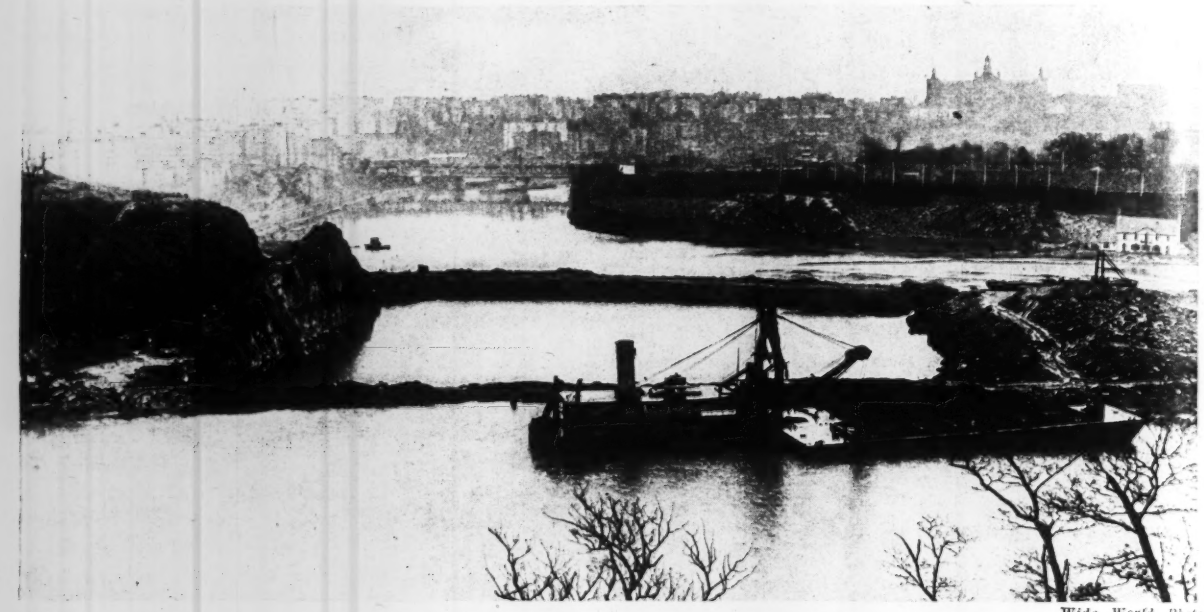
When the concrete art was young the builder's problems had a prominent place in all meetings and discussions. Formwork, mixing, transportation and placing of concrete, handling of steel and inserts, and finishing of surfaces, were recognized as being no less important than test cylinders and modulus ratios. By virtue of this breadth of discussion construction and design were able to go forward hand in hand, each well informed of the conditions and possibilities of the other. There is much less of this necessary contact today.

The biggest opportunity for useful cooperation lies in the type of construction that is remote from precise engineering control. Probably half of all concrete is produced and placed without the assistance of the skilled technician, and while the growth of central mix practice has extended some of the advantages of scientific practice to small-scale construction it is still true that a wide range of concrete work is done without knowledge of slump cones, scientific grading, and test cylinders. If the five or ten-yard job can be brought in touch with modern laboratory and design thinking it is certain that both practice and design will be strengthened.

Coincident with the decision to broaden the work of the Institute, an address by Frank T. Sheets placed timely emphasis on the need of translating research results into the language of the practical worker. He recalled to mind the fact that knowledge gained in the laboratory is of limited use until it is crystallized into actual happen only after the knowledge is expressed in construction practice, and this of course can terms intelligible to the man on the job, to whom research reports are uninteresting and barren.

It is also true that research facts often are in danger of misinterpretation unless they are seen in the light of everyday working conditions. Both reasons argue for constantly maintained contact of construction worker with his more scientific partners. In short, when construction workers join with designers and research men in common discussion all three will find themselves gainers, and the concrete art will make most rapid and consistent progress.

PICTURES IN THE NEWS



Wide World Photo

THE HARLEM RIVER SHIP CHANNEL at New York is being straightened and shortened by cutting across a rocky point around which the river now flows. The old channel will be used for park purposes and boat basins. New York Central tracks go through the point in the cut at the left.

ALL FOUR TRAFFIC LANES of the north approach to Golden Gate Bridge recently were blocked by a bad landslide. About 50,000 cu.yd. moved down from the side of the cut, which is 85 ft. deep at the point shown. This picture was taken after the top of the slide had been removed.

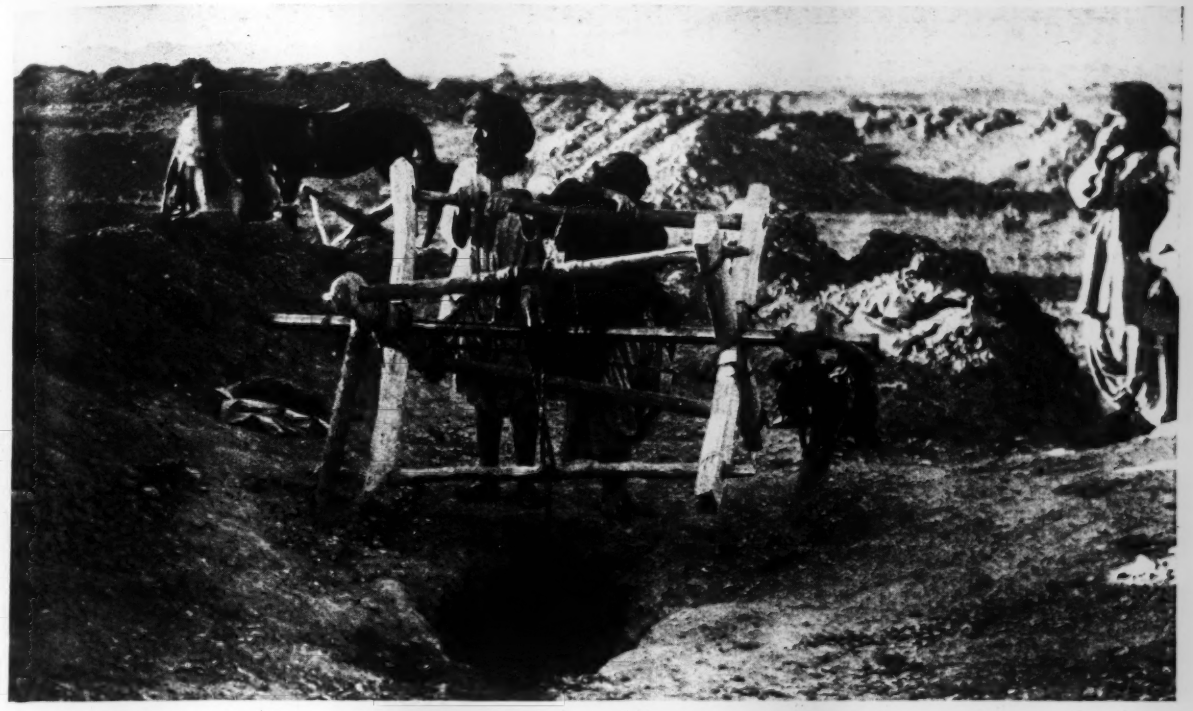


FIG. 1. PRIMITIVE METHODS CHARACTERIZE THE CONSTRUCTION OF UNDERGROUND WATER TUNNELS IN INDIA

Capturing Water In The Desert

by R. O. C. THOMPSON

Executive Engineer, Quetta (Earthquake) Reconstruction, North Western Railway, India

Across the barren semi-arid regions of India, irrigation water is made to flow by tapping underground storage basins

When the author read the article describing the desert water tanks which are used in the Southwest (ENR, July 1, 1937, page 36), he noted the similarity of this scheme to water conservation principles employed in semi-arid India. At the latter place "karezes" or underground channels, are constructed to tap water which is stored in the natural basins formed by detritus accumulations. The tunnels are built by native specialists who, without instruments for giving line and grade, display uncanny skill in digging from shaft to shaft. — EDITOR.

An observant traveller across the drab plateau of Baluchistan in northwest India cannot fail to notice numerous circular mounds of dried mud, depressed at the center like miniature volcanoes. Further observation reveals that these mud craters extend in fairly straight lines from the foot of a range of mountains to a village or a patch of cultivation (which may be several miles distant) near to which the craters cease, giving place to deep open cuts, and finally to cheerful streamlets of sparkling water. The mounds indicate the positions of shafts from which have been driven underground water channels or *karezes*.

The average annual rainfall in Baluchistan being only about eight inches, water is a very precious fluid. By means of the *karez* (pronounced to rhyme with erase) the water from melting snow and occasional storms which is absorbed into the stony floors of the torrent beds, is tapped sixty feet or so beneath the surface of the ground at the toes of fans of detritus where torrents debouch from the hills. From these places water is conducted through galleries which (being driven at a lesser slope than that of the plain) eventually reach the surface.

The work of constructing and repairing *karezes* is given by the *karez* owners, or "zamindars," entirely to specialists, of which the majority hail from Khorassan, a province of Afghanistan.

Construction methods

A karez is constructed by erecting primitive windlasses, and sinking rectangular shafts about 2x4 ft. in cross-section down to the water-bearing stratum at the foot of the hills. The shafts are connected by a narrow

tunnel driven in both directions and just large enough for a crouching man to work in. No instruments are used to give center line and level, and as the workers are incoherent or wilfully misleading in giving information, the method whereby the human moles succeed in joining up these burrows is difficult to discover.

Work is carried out by gangs of four, two below and two on the windlass at the shaft head. Of the two below one excavates, and the other crawls back and forth, half submerged in muddy slush in the black darkness, conveying the spoil to the foot of the shaft. From here it is drawn to the surface in a leather bucket attached to a slender grass rope. Mournful melodies and rhumblings from the depths indicate that work is in progress.

The *karez* would be a perfect device of its kind were it not for one or two weak points attributable to natural causes (such as earthquakes) but mainly to the indifference of *karez* owners. Partly as a result of injudicious deepening, and partly from stormwater finding its way into the tunnel down neglected shafts, internal earth falls take place. These are removed from time to time, the tunnel gradually assuming the form of a cavern. Sooner or later the *karez* collapses, rendering useless a wide strip of land at the surface. When such a collapse occurs under a road or railway the "zamindar" usually files through the local political agent a complaint for loss of crops through stoppage of water, alleging vibration as the cause of the subsidence. In order to safeguard the traveling public the railway authorities line *karez* tunnels under the right of way at their own cost, such being the local custom.

It is for reasons such as these that engineers do not as a rule regard *karez* owners with the esteem with which one professional man should regard another.

No evaporation losses

One of the most striking properties of the *karez* system is the almost miraculous way in which it produces cool, crystal, water from an apparently waterless desert. The barren (for the most part tertiary limestone) ranges are the natural reservoirs of Baluchistan, and the water trapped in the subsoil is not subject to loss by evaporation as would be the case in open reservoirs. In the mountains of Baluchistan, situated as they are on the fringe of the desert belt which encircles our northern hemisphere, including the arid regions in the United States, one may walk all day and find not a drop of water, yet explore the fans of debris at the foot of almost any mountain range and

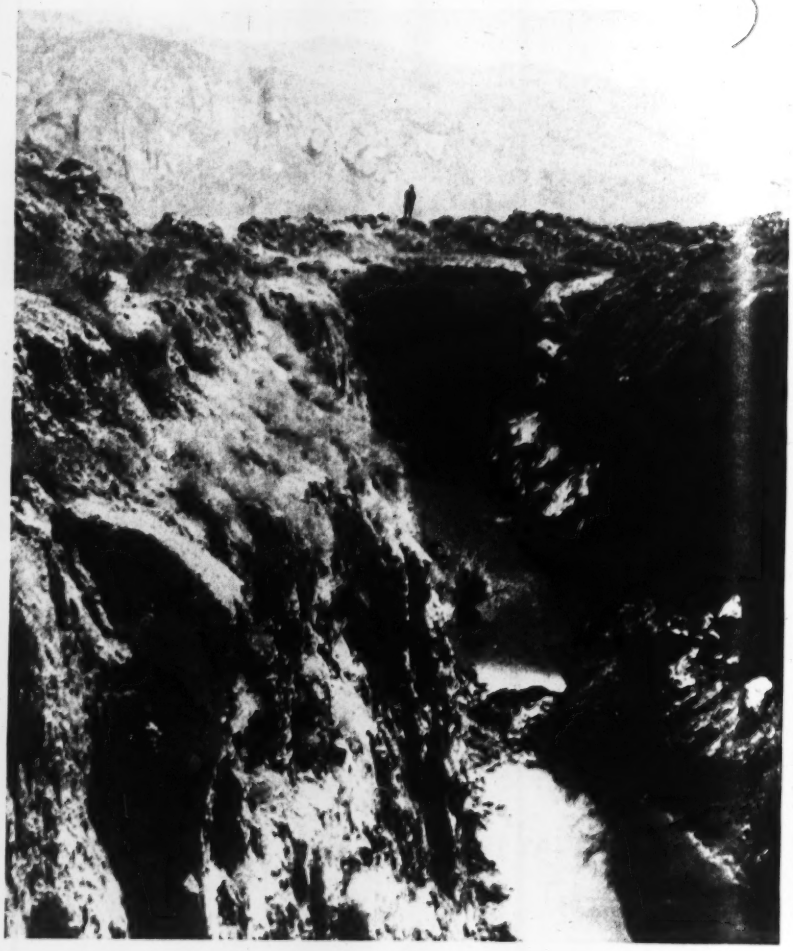


Fig. 2. Collapsed karez (water tunnel) which conveys water from natural underground storage basins.

Fig. 3. Karez diggers at work. Standing at the left (in the great coat) is the "zamindar" or foreman of the gang.

you will come upon an old *karez* shaft. Follow the line of shafts down until the *karez* becomes an open trench, and there is a stream of water so fresh and sparkling that you find yourself instinctively (but vainly) on the alert for a glimpse of the fleeting brown shadow of a startled trout.

The time is possibly not far off when, in districts such as Quetta, mechanical methods of raising water to the surface at the headsprings and thereafter conducting it along the surface in open channels will supplant the antiquated *karez*. Old customs in backward regions die hard, however, and probably for many years the *karez* digger with his antiquated equipment and his wierd subterranean rumblings will continue to honeycomb the soil of British Baluchistan.

How to Specify Disposal Equipment

Some practical considerations on securing fair and effective competition on bids for plant equipment

The following is an extract from an address by C. J. Velz before the annual convention of the New Jersey Association of Professional Engineers and Land Surveyors, Jan. 15, 1938. Until his recent appointment as a senior engineer in the New York regional office of PWA, Mr. Velz was acting chief engineer of PWA in New Jersey. — *Editor.*

COMPETITION is a controversial subject upon which there are decided differences of opinion and in which, as umpire, the engineer carries a heavy responsibility. Few challenge the principle of competitive bidding in public work; the law has frequent references to it, and the public has come to take it for granted. But the preparation of specifications for fair and effective competitive bidding is one of the most difficult tasks confronting the engineer, and in the sewage treatment field the task is complicated by the many patented processes and items of equipment involved.

In this mass production age, equipment is designed by the various manufacturers and offered in the market as more or less standard products. With the tremendous advancement made in the art, it would be a very unusual circumstance, where in the design of a sewage treatment works, selection was limited to one make. How open shall specifications be? Shall they be wide open to admit all, or so tightly closed as to eliminate all but one? Experience has shown that technical perfection must be balanced with reasonable cost. Somewhere between the extremes lies the desirable specification, which gives the consulting engineer equipment satisfactory for the purposes intended, at the same time preserves the valuable influences of fair and effective competition.

I do not believe that an age-old problem with complex ramifications can be resolved to simple terms; consequently, I shall present for your consideration a few observations from current practice.

In general: (1) The contractor should have sufficient information in the specifications so that when he solicits quotations from manufacturers he will be reasonably certain that such products will be acceptable; (2) the manufacturer, when quoting, should know clearly from the specifications that to obtain the order he must sharpen his pencil and that price will be the basis of award; (3) controversial items should be decided before bidding and clarified in the specifications rather than left as a risk and uncertainty in bidding; and (4) size of project permitting, contracts for major equipment should be direct with the manufacturer to insure maximum responsibility and minimum cost.

To protect the independent practice of professional engineering, and to insure fairness in competition, the engineer should jealously retain responsibility for design and specifications.

Two common methods of specifying equipment are by detailed description sufficiently broad to include features common to recognized manufacturers in the same class or by combination of description and the mention of three or more names of manufacturers as standards. In the first instance, it is difficult in a rapidly changing market to anticipate patented features which may limit competition. The mention of names of manufacturers as standards has the advantage of portraying a positive opportunity for competition. However, a sufficient number of mutually competitive firms must be mentioned, and unless three or more names can be stated, it is better to rely upon descriptive specifications. Even when clearly stated that it is to be used only as a standard, the mention of only one name usually impairs competition seriously.

In certain instances patented apparatus and treatment methods are such that to obtain competition it is necessary to resort to alternate proposals. In such cases the engineer should draw complete plans and specifications clearly to define the alternate method or apparatus, again jealously retaining responsibility for design. Price bid should determine the award with all other considerations clearly covered in the specification.

Frequently, initial cost is not the major consideration, and variations in operating cost affect the ultimate economy. If operating cost is to be considered in the award, a definite basis of computing ultimate economy should be clearly outlined in the specifications and set forth in the proposal. In order to protect against an irresponsible quotation on operating cost, it is desirable to require a bond for performance to be determined on the basis of carefully specified tests.

Fair and effective competition affords to the engineer the very basis of his existence and the opportunity for independent practice with high respect of the public; to the contractor it means freedom of opportunity and a reward for efficiency; to the manufacturer, it provides independence in business and marketing and a stimulus to improve products and develop new and better methods; and to the taxpayer, it is a dollars and cents approach to sound and economical public works construction.

Evaluating Highway Extensions

by Conde B. McCullough

Assistant State Highway Engineer, of Oregon, Salem, Ore.

An economic theory of highway planning in which solvency and desirability of road improvements are determined from vector addition of ratios of revenue and benefit to cost of the proposed new work

Highway economics embraces but three essential factor groups: (1) Costs, (2) revenues, and (3) benefits. Every problem involved within this field can be directly related to the proper correlation of these factor groups, and the soundness of any highway extension project may be measured by their various ratios.

Revenues must be sufficient to balance costs, otherwise eventual bankruptcy is inevitable. This tenet is fundamental, the conclusion obvious, but the criterion set up is not sufficient by itself. Highway revenues must also be backed up by corresponding benefits, else the setup eventually collapses for lack of public usefulness.

These three factor groups may be represented either in the form of capitalized or present values, or in the form of annual values. For simplicity the latter are used here. Annual cost, designated C_a, includes every item of expense involved in the construction, maintenance and operation of the highway or section of highway under consideration. Revenue or income, likewise reduced to an annual basis, is designated by I_a, while the annual benefit is designated B_a. Where it becomes necessary to differentiate between various components of the same factor group, a second appropriate subscript is employed.

Field of application

Problems involving an economic study of this kind present themselves to highway administrative bodies in various forms. There are demands for extensions to existing road systems. There are mandates from legislative assemblies for the selection of new highway mileage. Frequently there exists a necessity for an economic evaluation of relocations and cut-offs. And there is always the problem of determining an equitable priority basis for the improvements and extensions.

The solvency quotient

The first step is obviously the evaluation of the annual cost C_a, the annual road-user revenue or income I_{ar}, and the various annual benefits B_a. If they apply to a group of road projects for which it has been determined that road-user funds are to be used to defray the entire expense, it is apparent that the ratio I_{ar}/C_a is an index of the economic solvency of the project. If the ratio is less than unity, the project cannot be financed unless there exists a surplus of road-user revenues from other branches of the system to make up the deficit.

However, it is neither desirable nor equitable that road-user earnings be burdened with the entire cost of all of the highway systems of the state, since there are other beneficiaries, and these in all equity should bear part of the expense; nor is it possible to balance annual costs and road-user incomes to such a degree of nicety that the pro rata I_{ar}/C_a will remain constant for the highways in any particular group. It is possible, however, by dividing highways into certain broad groupings, to determine for each major group the approximate pro rata of cost which should, in equity, constitute a charge against the road user, and also to determine the manner in which the residuum should be pro-rated among the various remaining beneficiaries. This is obviously another problem entirely. The present problem is clearly one of selection, for which reason let it suffice to assume that the pro rata cost chargeable to road-user funds has already been determined and that the constant K_1 represents this allocation.

Clearly then, the ratio $I_a K_1/C_a$ represents the index of solvency or solvency quotient, Q_s for the project under consideration. If Q_s equals unity, the project is solvent, but not surplus-producing. If Q_s is greater than unity, a surplus for further highway extensions or improvements will be created. If Q_s is less than unity, the project cannot be justified on economic grounds alone, and in fact is not feasible unless there exists a revenue balance from other highways of the system to make up the deficit. Such a quotient, however, fails to furnish the sole criterion for the selection of the components of a highway extension program.

Let us assume, that in the locality indicated in Fig. 1 it is desired to select one additional road for placement on the state system, and that the choice has narrowed down to the two routes, "Project C" and "Project D." A physical survey and a traffic survey have been completed, designs and estimates of cost have been prepared and the following data have been derived:

Project "C"	
Annual cost (C_a)	$12,000
Present annual income	2,000
Estimated average annual income during service life, if improved (I_{ar})	7,000
Project "D"	
Annual cost (C_a)	$10,000
Present annual income	2,000
Estimated average annual income during service life, if improved (I_{ar})	8,000

Let it be further assumed that it has previously been established that 60 per cent of total road improve

ment costs for this particular system are to be defrayed from motor vehicle funds, and 40 per cent from funds derived from other sources.

Applying the solvency quotient method to the two projects under consideration:

For Project "C":

$$Q_s = \frac{\$7,000}{60\% \text{ of } \$12\,000} = \frac{70}{72} = 0.97$$

For Project "D":

$$Q_s = \frac{\$8,000}{60\% \text{ of } \$10,000} = \frac{8}{6} = 1.33$$

From the criterion of solvency quotients alone, Project "D" shows up quite favorably in the comparison and should therefore be selected. However, Project "C" acts not only as a feeder road but also as a state highway cut-off, in which capacity it operates to effect a large saving to traffic operating over the state highway routes in the direction indicated by the arrows in Fig. 1. This factor obviously has been disregarded entirely in the above analysis.

It is apparent, therefore, that the solvency quotient alone does not meet this situation. Judged solely by this criterion, cut-offs and line revisions could never find economic justification. Another factor enters into the problem, that of road-user benefits.

Road-user benefits

Before attempting to develop a numerical evaluation of the benefit quotient Q_B it becomes necessary to enumerate the various benefits involved, as follows:

1. Direct road-user benefits.
   - a. Mileage benefits.
     1. Fuel.
     2. Non-fuel.
   - b. Time benefits (non-fuel).
2. General benefits.
   - a. Commonwealth or national.
   - b. Community.
   - c. Land service or special property.

This breakdown yields two final classifications for road-user benefits, the first being a function of automotive fuel costs while the second is independent thereof. That such a segregation is necessary to a proper analysis will be developed subsequently.

Fuel benefits are clearly derived from a comparison of vehicular fuel consumption on the proposed route as against existing routes with the same termini. Such benefits are principally derived from reduction in distance, improvement in roadway surface, reduction in rise and fall, improvement in gradients, improved

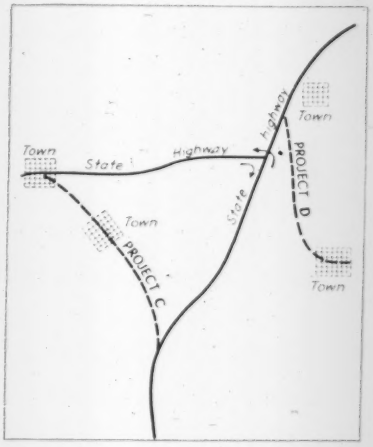


Fig. 1. A typical problem. Which is economically the more justified, project C or D?

alignment (reduced curvature, increased sight distance, etc.), and elimination of traffic stops.

Non-fuel benefits include savings in lubricants, tire and tubes, vehicle maintenance and a certain pro rata of vehicle depreciation. They also include time savings for drivers and passengers, and augmented traffic safety. Non-fuel benefits in the mileage group are, in general, derived from the same factors as above listed for the fuel class. The time benefits are also derived from these factors and from the following additional conditions: Increased roadway and shoulder widths, elimination of intersections and railroad grade crossings, and miscellaneous minor factors.

The benefit quotient

In order to illustrate the method, let it be assumed that for the particular project under consideration the fuel benefits have been determined as an annual value of B_f. Likewise, let B_n represent the annual value of the total non-fuel benefits to the road user. Let C_a represent the annual cost of the project under consideration and K_1C_a that portion of the annual cost to be defrayed from road-user funds. Then Q_B, the total benefit quotient, is

$$Q_B = \frac{B_f + B_n}{K_1C_a} \qquad (1)$$

It is obviously the sum of the two partial quotients Q_{Bf} and Q_{Bn} where

$$Q_{Bf} = \frac{B_f}{K_1C_a} \qquad (2)$$

$$Q_{Bn} = \frac{B_n}{K_1C_a} \qquad (3)$$

Combination of factor groups

The quotients above are clearly a measure of the desirability of the project from the standpoint of road-user benefits, and the question which next presents itself is this: How may these quotients be combined with the solvency quotient Q_s in order to arrive at a composite value which will, in a sense, measure the total ratio of interrelation between the three basic factor groups, cost, revenues and benefits?

Clearly they can not be added directly as scalar values. Neither does their multiplication yield a result that has much logic to defend it.

If, however, the component quotients are combined by geometric addition (Fig. 2) the result has a certain logical significance. The solvency quotient is entirely unrelated to road-user benefits and therefore has no component in the direction OY. The component benefit quotient Q_{Bn}, on the other hand, is entirely independent of road-user revenues, and may therefore be plotted in the direction OY. By laying off to any convenient scale the value Q_s along the axis OX, and from its outer terminus erecting a perpendicular whose scalar value is Q_{Bn}, the point c is located.

The factor Q_{Bf} remains to be added geometrically. Unlike the factor Q_{Bn} it is not unrelated to road-user revenues and in fact exists by virtue of a saving in motor vehicle fuel; for every dollar thus saved road-user revenues are correspondingly depleted. For the traffic which is developed on the road in question by and with itself, this depletion in road-user revenues will automatically be taken into consideration in determining the solvency quotient Q_s. In certain instances, however, particularly in the case of relocations and cut-offs, a certain portion of the traffic on the new project will be drained from existing highways and any saving in motor vehicle fuel accruing to this traffic is accompanied by a corresponding reduction in the total motor vehicle revenue on the

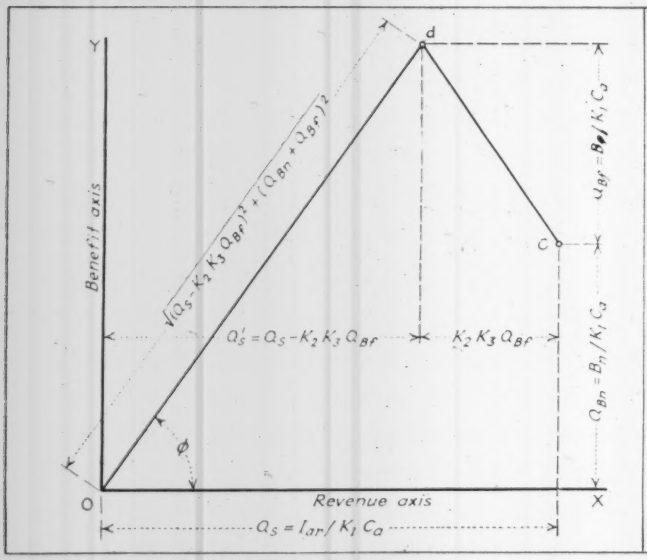


Fig. 2. Vector diagram showing in line *Od* the additive effect of solvency Q_s, non-fuel benefits Q_{Bn}, and fuel benefits Q_{Bf} less the loss in fuel tax revenue from shortened mileage on the cut-off route

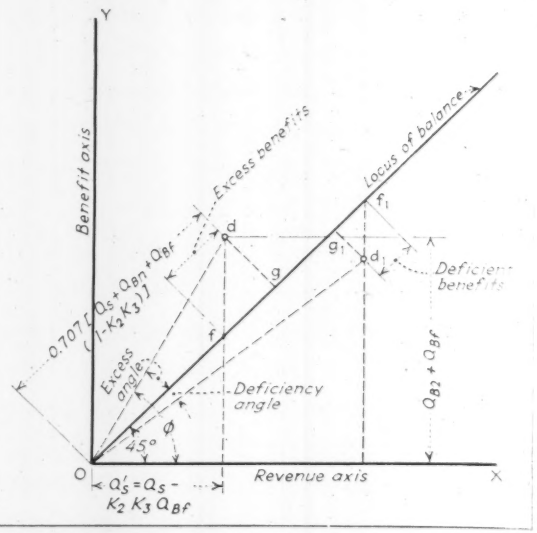


Fig. 3. A vector summation point such as *d* above a line bisecting the angle between the benefit and revenue axes shows excess benefits above revenues of *fg*. Likewise point d_1 shows a deficiency of benefits f_1g_1

system derived from fuel tax, for which reason the solvency of the existing system is affected.

In those cases, therefore, wherein a portion of the traffic on the project in question is to be derived from existing highway routes by virtue of distance savings or other similar factors, the benefit factor Q_{Bf} will carry along with it a corresponding reduction in revenue ratio. If K_2 represents the proportion of the total fuel savings which is derived from the traffic drained away from existing highway routes, and, if K_3 represents the ratio of fuel tax to total cost of fuel, the value of this revenue reduction component is given by the expression $K_2K_3Q_{Bf}$, which value is therefore laid off parallel to the *OX* axis, but in a negative direction from point *c* to locate the final terminal point *d*, Fig. 2.

Derivation of composite quotients

It should now be clear that the composite effect of all of these operative factors expressed in ratio form, may be represented both in scale and direction by the resultant line *Od*. Point *d* may be located directly, if desired, by means of the following equations (See Fig. 2):

$$Od = \sqrt{(Q_s - K_2K_3Q_{Bf})^2 + (Q_{Bn} + Q_{Bf})^2} \qquad (4)$$

$$\phi = \text{arc tan} \frac{Q_{Bn} + Q_{Bf}}{Q_s - K_2K_3Q_{Bf}} \qquad (5)$$

In a sense, the expression given in Eq. 4 represents the composite quotient value which we are attempting to derive, and could doubtless be used as such, since, after all, what we are seeking is simply a standardized method of combining benefit and revenue factors for use as a basis for comparing highway extension and improvement projects. Eq. 4, however, can be simplified and its use rendered somewhat more significant and logical by means of the following transformation:

In Fig. 3 is illustrated a condition wherein the terminal point *d* in the vector addition of revenue and benefit quotients has already been located. This obviously can be accomplished by means of Eq. 4 and 5 above. If, now, a third coordinate axis be constructed through the origin and at 45 deg. with the revenue and benefit axes, such axis will constitute the locus of all points which define an equality of benefits and revenues. This third axis may be termed the "locus of balance."

If the terminal point in any vector addition of revenue and benefit quotients falls on the 45-deg. axis, the condition defined is one wherein road-user benefits just balance motor vehicle revenues. In other words, the road user in this case derives benefits exactly commensurate with the taxes he pays (provided motor-vehicle imposts are used exclusively for highway purposes; and substantially so when the only diversion is for collection and administrative expense). There is no particular advantage to him, therefore, in having the road improved, as his savings in fuel, lubricants, tires, etc., coupled with his time savings simply accumulate a sufficient amount to pay his motor vehicle and fuel taxes, and no more. If the terminal point *d* falls above the locus of balance, the benefits derived exceed the imposts levied, and the intercept *fg*, obtained by dropping respective perpendiculars from point *d* upon the revenue axis and the balance locus, constitutes an index of the excess benefits thus derived.

If, on the other hand, the terminal point *d* falls at some point (such as d_1 in Fig. 3) below the balance locus, a deficiency in road-user benefits is indicated. Under such conditions there would appear to be insufficient justification for the road improvement contemplated. The road user's tax would exceed the benefits accruing to him. It would be to his advantage in this case to utilize present existing facilities.

From the foregoing analysis it appears that the construction of this "locus of balance" constitutes a simple method for graphically indi-

cating the relationship between benefit and revenue quotients and that the angles ϕ and intercepts fg measure such interrelation.

As stated, the scalar value of Od (determined by Eq. 4) may be used for the composite quotient value; however, if the vector Od be projected upon the locus of balance, the resultant value Og constitutes a somewhat more logical index. From Fig. 3 it will be seen that this value Og is given by the expression

$$Og = 0.707\ [Q_s + Q_{Bn} + Q_{Bf}(1 - K_2K_3)] \quad (6)$$

This last expression, therefore, represents as nearly as is possible mathematically the composite desirability of the project under analysis when each of the three basic factors (costs, revenues and benefits) is given due and proper consideration.

The solvency component of the vector Od is given by the expression

$$Q'_s = Q_s - K_2K_3Q_{Bf} \quad (7)$$

This represents the net ratio of road-user income to road costs for the project under analysis when due and proper consideration is given to the general depletion of road revenues arising by virtue of any decreased fuel consumption by traffic drained from existing highways on the system.

Summary of method

In brief, the method may be restated as follows:

(1) The financial soundness or economic expediency of selecting any new addition or improvement to an existing highway system can be measured by the solvency quotient

$$Q_s = \frac{I_{ar}}{K_1C_a} \quad (8)$$

where I_{ar} = the estimated average annual income from road-user taxes accruing to the project during its service life.

C_a = The average annual cost of the project inclusive of every item of expense involved in its construction, maintenance and operation.

K_1 = That fraction of total annual cost which is to be defrayed from road-user earnings.

If any part of the estimated road earnings is derived from traffic drained from any part of an existing highway system financed in whole or in part from road-user funds, such portion of the earnings shall not be considered in computing I_{ar}. Furthermore, in this latter case the solvency quotient Q_s shall be corrected by deducting the value $K_2K_3Q_{Bf}$, so that the revised solvency quotient shall be expressed as follows:

$$Q'_s = Q_s - K_2K_3Q_{Bf} \quad (9)$$

where

Q'_s = the revised or corrected solvency quotient.

Q_s = the original solvency quotient.

K_2 = the ratio of the fuel savings on all traffic drained from any existing highway system or systems to the total fuel savings.

K_3 = the ratio of motor fuel tax to total fuel cost.

Q_{Bf} = the ratio B_f/K_1C_a where

B_f = the benefits accruing to traffic on the project which are "fuel functions," in other words, the total fuel savings.

(2) The composite desirability or order of preference for any project when road-user benefits as well as highway incomes are considered may be expressed numerically by the composite quotient Q_c which is determined by the expression

$$Q_c = 0.707\ [Q_s + Q_{Bn} + Q_{Bf}(1 - K_2K_3)] \quad (10)$$

where Q_{Bn} = the ratio B_n/K_1C_a, and where B_n represents the benefits to traffic on the project other than fuel savings.

In conclusion, it should again be emphasized that the selection of highway improvements is not a problem susceptible of exact mathematical solution. After all is said and done, the final selection must be, to a certain extent, tempered by judgment and a knowledge of individual conditions and needs. The most that can be expected from the above is the development of a somewhat crude measuring stick and a method which can be employed to indicate graphically the interrelation of the factors involved.

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City Manager Plan of Government Shows Steady Growth in 30 Years

CITY MANAGER GOVERNMENT celebrated its thirtieth birthday in January. The movement which began when Staunton, Va. passed an ordinance in January, 1908, to hire a "general manager," has grown to include, in January, 1938, a total of 465 cities and 7 counties, according to the International City Managers' Association. Eleven cities in 1937 became council-manager cities.

First large city to attempt the new governmental experiment was Dayton, O., following the devastating flood in the spring of 1913, when the incumbent government failed to function effectively. Dayton and Springfield, O., installed the plan on January 1, 1914.

Acceptance of the new form of government during the following years was widespread among cities concerned with adopting new charters. From 1911-20, of all the charters adopted in 11 home-rule states, 35 per cent were of the council-manager type. In the next decade this percentage increased to 71.

Council-manager municipalities in the United States range in size from Polk City, Fla., with a population of 222, to Cincinnati, O., population 451,160. In addition to the cities and counties under an "approved" form of the manager plan, there are 155 other cities and 36 counties that have some modification of it. San Francisco is the largest city that might be considered as having a modified form of the manager plan. An "approved" council-manager municipality, according to the I.C.M.A., must appoint the manager by an elected council; must make him solely responsible to the council for administrative affairs, and must give him broad appointment and removal powers over administrative officers subject to civil service regulations.

The 472 council-manager governments include 19 cities outside the United States: 14 in Canada, 4 in Ireland and 1 in Porto Rico. Seventeen of the 94 U. S. cities with over 100,000 inhabitants are council-manager cities.

Tower Reconstruction Completed

by R. F. EGELHOFF

Superintendent, Turner Construction Co., Boston, Mass.

Ingenious utilization of roofs and cloister ekes out limited working area for construction operations involved tower reconstruction at Old South Church

THE TOWER of Boston's new Old South Church rebuilt a blunt five stories high about five years ago was last year completed to its original graceful roof peak 220 ft. above street level. Besides restoring a landmark dear to Bostonians, the work was a nice example of the consideration of the public in carrying on construction. During all the weeks of work the church was open for worship and the normal life of the street was uninterrupted. No accident occurred in all the work. The means adopted to these ends are the story of the tower construction.

Chain of replacements

The old South Church of Boston was erected in 1669 at Washington and Milk streets. This church was replaced in 1730 by the Old South Meeting House which still remains a historic landmark. In 1875 a new stone church and tower were constructed at Dartmouth and Boylston streets on Copley Square. Constructed of heavy masonry, the structure, rising to a height of 240 ft. above the street, towered well above all neighboring structures in the Copley Square district. The walls of solid masonry varied in thickness from 30 to 60 in.; many of the stones used high up in the tower weighed up to 3 tons.

Indications of leaning and of settlement in the tower became apparent soon after its erection. By 1920 the tilt had increased to a point where the tower was 2½ ft. out of plumb and large cracks had opened up in the walls. Demolition of the tower became necessary in 1930 and in the hope that restoration of the structure might become possible at some future time the stone removed was stored in a local yard.

Reconstruction of the lower portion of the tower, together with the construction of a new chapel and parish house adjoining the tower, were begun in the fall of 1931. The foundations had previously been strengthened by pretest piles to support a tower of full height. Under this project the lower portion of the tower was rebuilt to a height of 70 ft. above the sidewalk. Provision was made in the new design to reduce materially the loads to be put on the foundations; the total foundation loading for the old tower was 5,000 tons as compared with 2,500 tons for the reconstructed tower. This reduction was attained by a structural steel frame and light stone walls backed with brick; the walls, with the exception of the belt courses and overhangs, were held to a thickness of 14 in. Old stone from the original tower was used in the construction.

Fig. 1. Boston's Old South Church tower under construction

Work on the restoration of the upper portion of the tower was started in April, 1937. Unlike the original construction in 1875 and the partial reconstruction in 1931 construction operations were restricted and this was the source of numerous job problems.

Finding working room

The building contract stipulated that in no event should the construction operations interfere with any of the church activities. Entrance to the church and the parish house was through the tower at sidewalk level; this was to be kept clear and safe for the parishioners and the public. To handle this problem the job office, tool room and church entrance were combined in one substantial safe structure of appearance and design to harmonize with the church and to retain much of the inviting effect of the church entrance itself.

Owing to the small size of the tower and the fact that it was already constructed to a height of five stories above the sidewalk the hoisting of all materials used in the reconstruction had to be done outside of the tower. Working-yard and storage space at the site was limited. It therefore was essential that such space as was available be used to

the very best advantage. Fig. 2 shows how this space was used to afford ease in receiving, storing, handling and hoisting materials. The fence enclosing the storage space was designed to carry out the general appearance of the temporary entrance structure and to hide from the view of the public any unsightliness of the yard.

The adequate protection of the several church roofs and the parish house roof, while not a difficult problem, was one which it was necessary to work out in careful detail in order that the protection be positive and that it might be used for working and storage decks. Protection on sloped roofs was designed to provide horizontal storage areas in such a way that loads would be well distributed over the roof areas and that possibility of slippage might be avoided.

Prior to starting actual construction it was necessary to remove the roof of the partly reconstructed tower and to expose the structural steel columns in the old walls for new column connections. A temporary waterproof deck was installed at the old top floor level to seal the lower portion of the tower against damage from water and from building operations above.

Novel scaffolding devised

The most important of construction problems was that of safety to pedestrians, to street traffic and to the workmen. Much preliminary study was given this matter and no damage or injury resulted from the entire construction operation. The street face of the tower being but 20 ft. from the path of pedestrians on the sidewalk made it evident that the greatest factor of safety to pedestrians and street traffic lay in careful scaffolding. Complete tubular steel scaffolding from grade to the top of the tower was seriously considered but was eliminated on account of difficulties in supporting such scaffold on the old roofs and partially for the reason that it did not lend itself well to the handling of heavy stones occurring at the bell-deck level of tower.

The scheme eventually adopted is shown in Figs. 1 and 3. It consisted of structural steel outriggers at the belfry openings and anchored to the permanent tower steelwork at the

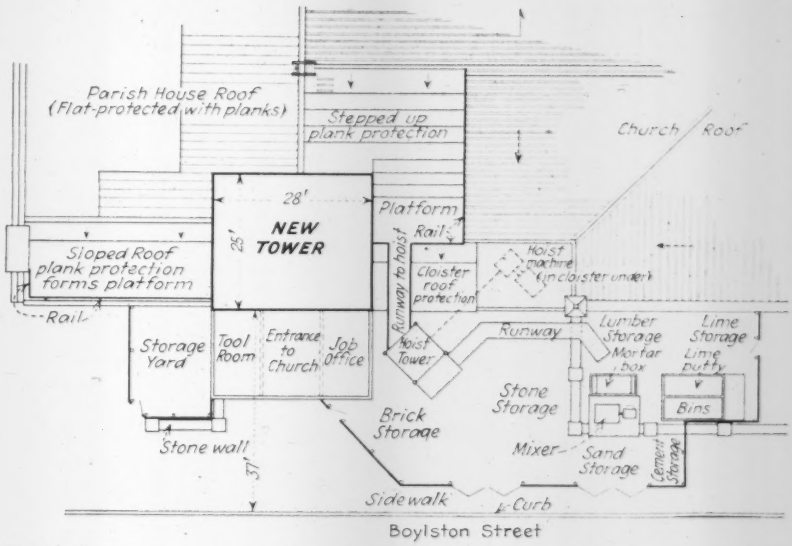

Fig. 2. Plant layout designed to utilize limited space available for constructing the Old South Church tower in Boston

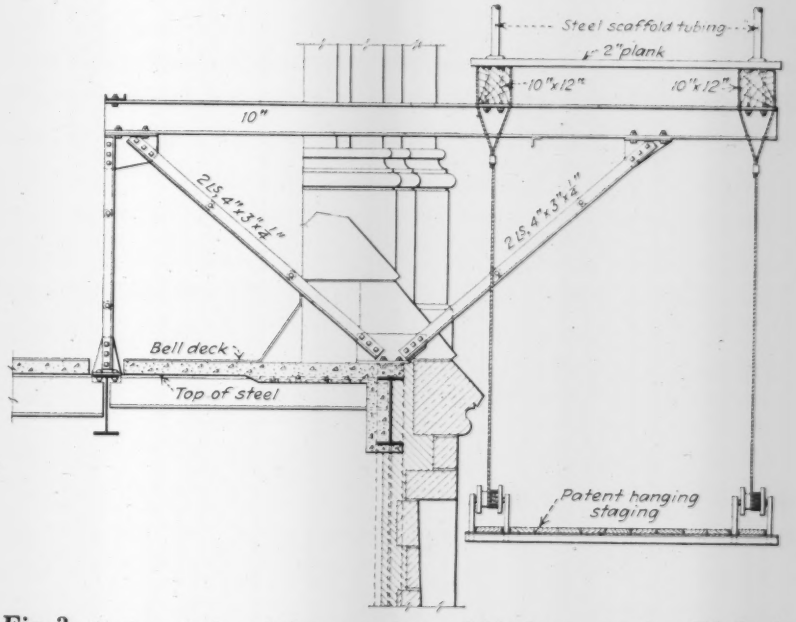

Fig. 3. Section of ring platform carrying scaffolds for constructing Old South Church tower

bell deck. To these outriggers 10x12 in. timber stringers were bolted, the whole framework tied together, and a patent scaffold 6½ ft. wide suspended from the timbers. The swinging patent scaffold below outriggers was used for laying all exterior masonry work up to the level of the outriggers. Each scaffold machine was figured to take a maximum load of 6,000 lb. without causing overload in the outrigger timbers. The outrigger timbers were planked over and a tubular steel scaffold was carried from this deck to the top of masonry work, a height of 52 ft. Steeple scaffolding was necessary only for the use of the roofers. This was of wood construction starting at the base of the steeple and extending for a height of 54 ft. or to a point 220 ft. above the sidewalk.

The lower sections of structural steel framing were erected with a tractor crane from sidewalk level. The upper portions were erected with a mast derrick from the several floor levels of the tower.

It was the intent of the architects and the building committee to re-

produce the old tower with but slight architectural variations and in general to have the reconstructed tower harmonize in color and texture with that of the old tower. Old stone from the original tower was therefore used throughout. Setting plans were prepared and old stone was recut to meet the requirements of the light wall construction. Such of the stone where old faces could be reused were already colored and darkened by time and the elements. All newly cut faces were colored to match as nearly as possible the color of the aged stone. In the case of the brown stone and the white stone coloring was done at the cutting yard. Pudding stone was colored after it was set in the wall. Cutting and age treatment of stone was done by the building contractor with his own labor.

The architectural design in the reconstruction of the new Old South Church Tower was by Allen, Collins & Willis, structural design by J. R. Worcester & Co., and construction by the Turner Construction Co.

Eastern Roadbuilders Survey Problems at Atlantic City

Superhighway design, chloride resistant concrete and accident control measures reviewed by highway officials of North Atlantic states

KEEPING ITS RECORD for large attendance the Association of Highway Officials of the North Atlantic States marked up a registration of over 1,200 at its annual convention held at Atlantic City, N. J., Feb. 16-18. The four technical sessions devoted respectively to safety, design and construction, maintenance and materials, called together audiences of 100 to 150, which gave close attention to the score of formal papers and discussions. Voluntary discussion from the floor was small. At the business session, Francis J. Whalen, Connecticut State Highway Department, vice-president of the association, was made president and James Logan, state highway engineer of New Jersey was elected vice-president.

Safety stressed

Thinking on safe highways and safe operation of highways colored addresses and discussion throughout the sessions. Acting president Whalen, in opening the convention spoke particularly of main roads as extensively in need of widening and straightening and of wide stabilized shoulders, flattened ditch and back slopes, and, where four or more traffic lanes were required, for a neutral zone separating opposing currents of traffic. Need of these improvements, said Mr. Whalen, was so great that any diversion of road funds denied road users of both the safety and the service to which they were entitled. In welcoming the convention for Governor A. Harry Moore, E. Donald Sterner, state highway commissioner of New Jersey, took up again the argument for main-road renovation if present-day traffic volumes and speeds were to be carried safely.

Speaking of driver education in safety Ralph L. Lee, General Motors Corp., stated that accidents resulted from (1) the driver doing the thing he knew was wrong, (2) the driver doing the thing he did not know was wrong and (3) from causes the driver could not avoid. He added that the first was the most common cause. As to education, he felt that it should be carried on through safety officials and not by organizations or individuals, should not be conditioned on the assumption that the driver is a moron and should hammer away at the lesson that every driver will sometime come to judgment if he continues to break traffic laws. To this end, said Mr. Lee, "impartial enforcement and inflexible courts are necessary—new rules and new laws are not needed."

Testimony on this last statement was given in the paper on highway safety and planning by S. W. Marshall, chief engineer Pennsylvania department of highways. Referring to the new 50-mi. speed-limit law, Mr. Marshall stated that close policing and invariable and rigid enforcement of penalties had greatly reduced violations and lessened accidents due to driving speeds that road conditions made hazardous.

The remaining papers on safety were devoted to traffic control and warning signs and markings. In the opening paper on these traffic aids, David Noonan, assistant commissioner of maintenance, New York state highway bureau, emphasized the use of reflector-button signs. The readability of a sign at night, he said, is even more important than its readability by day and a well-designed reflector-button sign provided clear visibility in both daylight and darkness. So as to be effective, however, the use of button signs must be restricted to traffic signs; their use for advertising purposes along the highway should be discouraged.

In discussing Mr. Noonan's paper, D. V. Z. Bogert, county assistant engineer, New York state highway bureau, stated that there is great danger of getting too many road signs. Also too many are wrongly located.

Discussing road marking and particularly pavement striping, R. M. Reindollar, assistant chief engineer, Maryland state roads department, explained the new striping practice used on three-lane roads on hills. Maryland uses a yellow traffic stripe where this stripe is not to be crossed a parallel or bordering white stripe is painted on each side of the yellow stripe; in the Maryland code a white stripe means "not to be crossed." At a hill on a three-lane road, the triple stripe marks off the outside (right-hand) lane for vehicles to ascend the hill in a single line. At the crest of the hill the triple stripe swings left diagonally across the center lane and continues down the hill on the inside of the left hand outer lane. By this arrangement vehicles ascending the hill in a single line have at the top two clear lanes to get away and line out according to speed.

Design and construction

Some problems of the superhighway were discussed in the opening paper of this session road by G. H.

Delano, chief engineer, Massachusetts department of public works. Defining a superhighway as at present understood, as any highway having a physical separation between opposing streams of traffic, constructed to modern standards and with highway grade separations at least at the more important intersections, Mr. Delano predicted that in a few years this definition will be altered and that no road that is not a freeway or at least has some restrictions on access by abutters will be considered a superhighway.

Some broad questions of purpose and location are involved in superhighways. It is simple enough, said Mr. Delano, to think of a superhighway to connect two cities but this is not the whole problem. To stop the road at the two cities and dump the traffic onto the city streets is not superhighway planning. Again, consideration has to be given to the long-time change in the distribution of population and location of industry that may follow the new highway facility. Conceivably one area of a city may be adversely affected by a superhighway in another area; the city may even lose population while the suburbs grow. These are not all the questions that arise but they indicate that planning these great express roads is no small problem.

Turning to details of structure, Mr. Delano described the design of the Newburyport Turnpike, the latest of the Massachusetts super-roads, constructed in 1937. Each roadway has a 12-ft. inside passing lane, two 11-ft. travel lanes, a 10-ft. parking lane and a hard-surfaced sidewalk. The roadways are separated by a parting strip of variable but always at least 20-ft. width at openings for traffic to cross from one roadway to the other. Sloped curbs (45 deg.) border the parting strip and along them are catchbasins to take the surface drainage from the inside slopes of the roadways which are crowned at the center. Grades are separated at important cross-roads with interchange ramps of full clover-leaf design where possible. In later designs grade separations are planned for all cross roads but no ramps or other means of traffic interchange will be provided at crossings of small importance.

Commenting on this design, Mr. Delano said, that one serious hazard that remains is access by abutters; present Massachusetts laws do not permit this to be denied. It is hoped to have these laws changed to permit freeway construction. In discussion, W. W. Mack, state highway engineer of Delaware, said that a separating strip 50 ft. wide had been adopted for the DuPont dual highway south from Wilmington.

A paper by Capt. H. C. Whitehurst, director of highways, District of Columbia, described plans being considered for handling traffic at a number of the city circles. Despite all practicable aids to routing and time control congestion is serious and plans are in hand to separate grades so as to give main routes a freeway through the circle. Squire E. Fitch, highway superintendent of Chautauqua county, New York, described the succession of five-year plans and budgets by which the county has systematically improved its systems of secondary and tertiary roads.

Current methods of maintenance were described in papers by James E. Lawrence, Massachusetts, W. W. Mack, Delaware, A. W. Muir, New Jersey, D. P. Campbell, Maryland. H. E. Sargent, Vermont and H. C. Shinn, Ocean County, New Jersey. Processes and materials in current use were described circumstantially and full reading of the papers is necessary for useful understanding.

Materials

Interest in the discussion of materials centered on study of the chloride resistance of blended natural and portland cements. New developments in roadbuilding tars and asphalts were reviewed by A. R. Taylor, Koppers Co., and B. E. Gray, Asphalt Institute, M. D. Catton, Portland Cement Association, outlined developments in soil-cement stabilization. Developments in the use of the Los Angeles rattler test were describd by F. H. Jackson, Bureau of Public Roads. Most of these advances were reviewed by the same authors in *Engineering News-Record*, Jan. 13, 1938 or will be described later in more detail.

A paper by Ira T. Paul, associate laboratory engineer, New York state highway bureau, presented a noteworthy volume of test results on sodium and calcium chloride attacks on straight portland and blended cement concrete. The tests were made on cores drilled from parallel lanes of pavement, one lane being straight portland concrete and the other lane a blended-portland concrete. The cores were immersed in 10 per cent chloride solutions and subjected to alternate freezing and thawing every 24 hours; one set was subjected to 25 cycles and the other to 50 cycles. Differences were observed between tricalcium aluminate and tricalcium silicate cements and in other respects, but the noteworthy result was that there was complete failure of most of the straight portland-cement concretes and almost complete resistance to chloride attack of the blended-cement concretes. The blend ratios used (natural to portland) were 1 to 5 and 2 to 5 by measurement; generally the 2 to 5 blend showed the higher resistance but the difference was small.

Observations of the pavements to which liberal doses of chlorides has been applied for ice removal showed active scaling of the straight portland and no scaling of the blended concrete. Where the chloride solution could stand on the portland concrete the scaling was increased.

In discussion H. S. Mattimore, Pennsylvania highway department, expressed belief that study of the tests in detail would indicate inconsistencies that should warn users against too hasty condemnation of straight portland-cement concrete.

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How Close Do Cars Pass?

MOTION PICTURE records from a car in train with regular traffic made by an observer of the Bureau of Public Roads show that motorists usually allow ample clearance in passing other vehicles. Both cars and trucks follow the centerlines of traffic lanes closely when being passed. The average clearance of passenger cars overtaking and passing other passenger cars ranges from 3.8 ft. on 18-ft. surfaces to 4.9 ft. on 22-ft. surfaces. For opposite-direction passing the range is from 4.0 ft. to 5.7 ft.

In general, it was found that roads 18 ft. wide are too narrow either for passenger cars alone or for mixed traffic; that pavements 20 ft. wide are inadequate for dense traffic involving trucks, but are reasonably satisfactory for the more lightly traveled roads with few trucks and that a road width of 22 ft. is entirely adequate, safe and comfortable for modern mixed traffic.

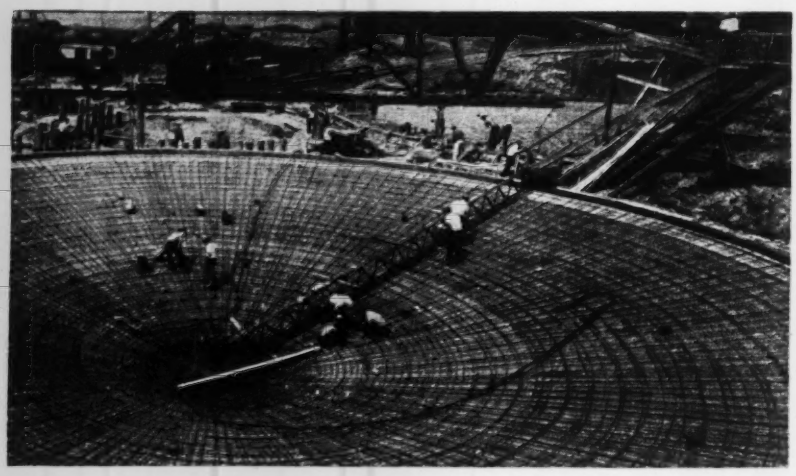

FIG. 1. ROTATING TRUSS SCREED FOR PLACING DISHED CONCRETE FLOOR SLAB.

Special Rigs Speed Concreting On Circular Sewage Tanks

Rotating truss screed for sloping bottoms and whirligig chute for wall placement are featured

TWO SIMPLE but highly effective mechanical aids to concrete placement have speeded up construction of the circular, sloping bottom, sludge digestion tanks on the new Buffalo sewage disposal plant. One is a rotating truss screed that struck off the bottom slab concrete to the correct pitch and thickness. The other is a whirligig chute arrangement for depositing concrete in the high circular walls in even spiral courses.

The tanks are 90 ft. in diameter, 20 ft. high, with walls 12 in. thick topped by a coping. The tank bottoms are monolithic reinforced concrete slabs 10 in. thick, sloped or dished downward toward the center on a 1:4 slope. Concrete was transit mixed, 3 in. slump, delivered to bottom-dump buckets directly from the mixer trucks. A steel derrick handles the concrete buckets.

The screed was a lattice truss of two top and two bottom angles $2\frac{1}{2}$x$2\frac{1}{2}$x$\frac{1}{4}$ in., 2 ft. 4 in. back to back and 46 ft. long. The lower or center end of the truss was supported on a vertical pipe pin set on a concrete base. The outer or upper end of the screed was carried by two wheelbarrow wheels set in tandem, riding on the previously-poured concrete wall base. The truss was braced by two 1 9/16-in. hog rods.

The two bottom angles served as the screed, effectively striking off the concrete as the truss was rotated around the center pin. A tractor hooked to the outer end of the truss by a cable provided the motive power for rotation.

The wall placing whirligig consisted of a chute about 50 ft. long, one end mounted on a central steel tower, the other end supported by two pneumatic-tired wheels riding on a shelf at the top inside of the forms. A conical hopper was mounted above the center end of the chute. Both the hopper and chute revolved on a table at the top of the tower.

A slab of plywood carried along by a laborer served as a backstop at the discharge end of the chute. The chute was revolved by hand.

Both rigs are shown in the accompanying illustrations. They were devised by John Masoni, superintendent for Lombardo Bros. Const. Co., of Cleveland, which is building the sludge disposal tanks for the Buffalo Sewage Authority.

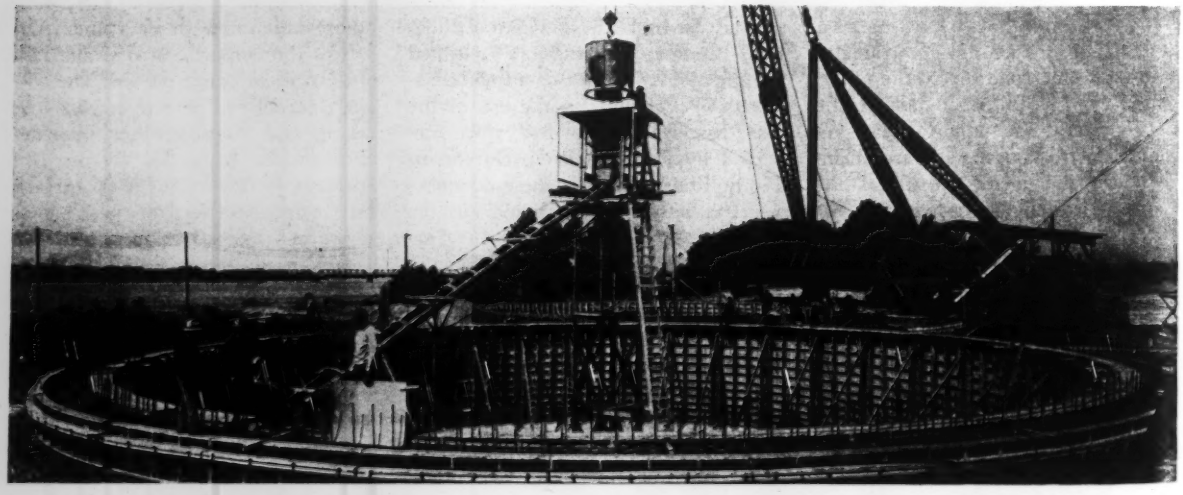

Fig. 2. Whirligig chute arrangement permits placing of concrete in circular tank walls in even spiral courses.

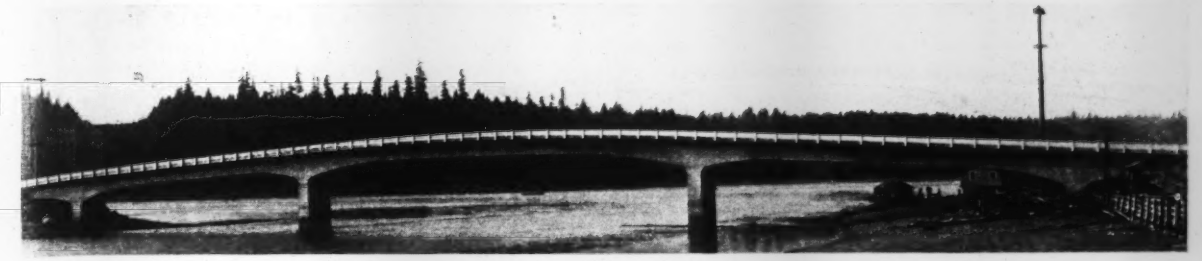

FIG. 1. THE BOX-GIRDER TYPE OF BRIDGE STRUCTURE LENDS ITSELF WELL TO ARCHITECTURAL EFFECTS

Concrete Box-Girders of Record Span

by F. R. EASTERDAY
County Engineer, Pierce County, Wash.*

Low-cost highway bridge on Puget Sound has continuous hollow girders with central span of 190 ft. and 140-ft. side spans

A CENTRAL SPAN of 190 ft., believed to be the longest of the hollow, box-girder concrete type thus far built, is the notable feature of a two-lane highway bridge recently completed across Henderson Bay, an arm of Puget Sound at Purdy, Pierce Co., Wash. The structure has a roadway width of 20 ft., three spans; 140, 190 and 140 ft. long, respectively, with 40-ft. cantilever ends and employs the continuous design principle for *H*-15 loading. The major advantage in a design of this type is its low cost: in this structure the total cost is only about $62,000 or $5.64 per sq. ft. of net roadway width. More complete cost details are given in the accompanying table; reasons for selecting this design and the method of construction used are outlined below.

About a mile from the head of Henderson Bay, a long gravel spit extends out nearly 2,000 ft. from the western shore, entirely closing off the head of the Bay except for a 500-ft. channel near the east shore. Through this channel strong currents are caused by the ebb and flow of the tides which have a maximum 17-ft. range here and hence set up velocities of 8 or 9 mi. per hr. For many years, a county road has crossed this channel on a bridge: when replacement recently became necessary the whole question of type and span layout was studied in the light of design progress in recent years.

Because of occasional commercial use of the upper bay, an 18-ft. clearance at high tide for a 100-ft. channel was required by the War Department. It was recognized that pier construction carried down to a depth of 20 ft. or more below mean tide would be costly and that the strong run of the tide would introduce scour risks. Therefore, although new piers for the channel span would have to be provided, it was reasoned that the fewer the additional piers in deep water the lower would be the cost of the bridge. Pier shafts of fairly large size, poured in the dry, would have the most favorable shape and section for exposure of concrete to sea water. Also, symmetry of spans and grades with good proportions in the main members would go far toward giving a pleasing appearance.

These several considerations led to the adoption of the span arrangement shown in the accompanying illustrations. A grade of 5.8 per cent was required on the eastern approach to the bridge and to give symmetry to the structure the same grade was repeated on the opposite end. The central span, from end to end, is a circular, vertical curve. The easterly pier of the central span was located 14 ft. east of the easterly pier of the old bridge. This was the control point for the entire structure since the required channel lay immediately to the west of the former pier.

If consideration is given to concrete girder spans of 100 to 250 ft. it will be found they are most economical if built of the hollow, cellular type. Solid web girders if kept below the roadway level are automatically eliminated by their dead weight; if made of the half-through type extending above the roadway level, they must be of considerable depth and lose all the benefits of flange action that are available in the road slab.

Hollow box-girders, on the contrary, are of minimum section and weight, make use of the full roadway slab as a compression flange for positive bending, can easily be given adequate section for negative bending, afford ample space for tension reinforcement, and if braced with transverse internal diaphragms, undoubtedly have the strongest section that can be made with a given quantity of material. Thin webs, held rigidly at top and bottom by roadway and soffit slabs can be of the minimum thickness required by shear. They present to the weather a maximum amount of smooth plane surface and a minimum number of corners. Hence this section was best suited to this case and was used to the complete satisfaction of all concerned.

As end piers of the bridge are fairly short and are largely in the banks, they are practically fixed points. It appears—from climatic exposure, grades of deck and cellular construction—that the entire deck structure probably could have been

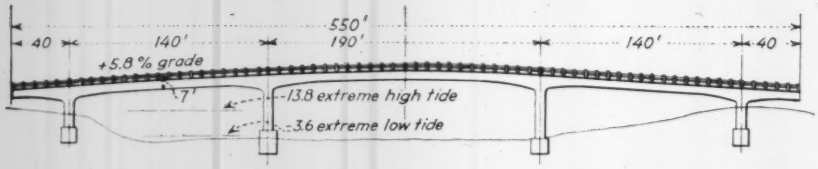

Fig. 2. Elevation of the Purdy Bridge showing span arrangement.

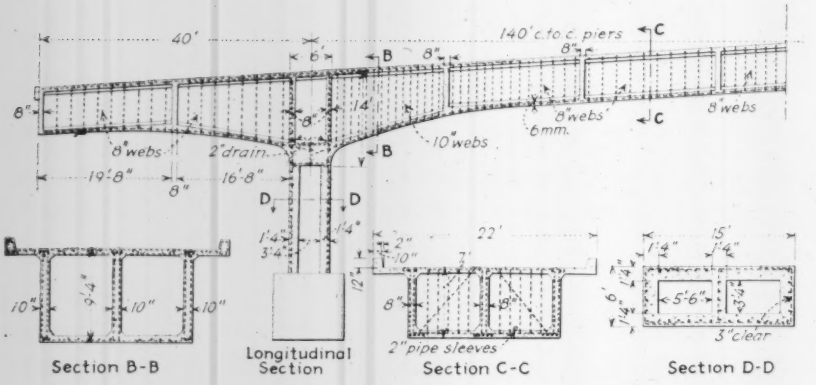

Fig. 3. Elevation and sections showing box-girder details.

made continuous from end to end with only a few cold joints for construction purposes. In deference to convention, however, expansion joints were put at each end of the 100-ft. mid section in the 190-ft. span. The middle section is completely separated from the remainder of the structure and hence was designed as a simple, suspended beam.

This suspended span is seated on shelves formed in end sections of the 190-ft. span which are continuous with the deck structure of the 140-ft. spans beyond them, and cantilever out over the channel piers as shown in Fig. 2. The bearing is simply two plates separated by a sheet of asbestos packing. The shelf is 12½ ft. long, thus utilizing most of the total box-girder breadth of 15 ft. The 15-in. solid concrete sections at the ends of the shelf serve to lock in laterally the end of the suspended section that bears upon the shelf and cause the joints in side view to appear as a vertical cut.

Construction of this sort does not permit removal of forms which give desired shape and clearances to the ends of the suspended span. Special end forms of sheet metal braced with stiffener angles were therefore specified and were left in place.

The box girder, of which the roadway slab forms the top flange, is 15 ft. wide, and 7 ft. deep at the crown, increasing to 14 ft. at the piers, has three webs (two at the sides and one at the center line) and a bottom slab which is 6 in. thick in the tension zone and of greater thickness in the compression zone, as stresses require. The webs were given a minimum thickness of 8 in. which is increased toward the supports as shear stresses require. At about 20-ft. intervals 8-in. transverse diaphragms brace and interconnect all longitudinally extending parts. There can be no reasonable doubt as to the unitary nature of the resulting construction. The use of 2-in. square bars for the main tension steel gave concentration of reinforcing close to the webs which was preferred by engineers who checked the plans for the concrete box-girder bridge.

The pier shafts 6x15 ft. in plan are flush with the outer sides of the deck box-girder and are likewise cellular. Shells and webs are 16 in. thick, and as protection from sea water, have a minimum cover of 3 in. of the class A concrete (1.81 bbl. of cement per cu. yd.) All piers bear directly on firm compacted gravel closely filled with sand; no piles were used, although at first they were planned for the end piers. Small openings through the diaphragms of the box-girder provide means of escape for any water that may enter. The drains finally discharge into the interior of the pier shafts which have outlet openings above the footings.

TABLE I — DEFLECTIONS AFTER REMOVAL OF TEST LOAD

Location	Reading (feet)
End of west cantilever	−0.007
West End pier	−0.047
West 140 ft. girder, 40 ft. out	−0.066
Midspan	−0.056
West channel pier	−0.043
West expansion joint	−0.112
Middle of suspended span	−0.188
East expansion joint	−0.104
East channel pier	−0.039
East 140 ft. girder — midspan	−0.042
East end pier	−0.033
End of east cantilever	+0.002

Construction methods

Except for an unusual number of delays, particularly bad winter weather, which came during work on the foundation, no difficulties attended the construction. After the piers were in, the remainder of the work progressed rapidly. The contractor built a construction trestle alongside and clear of the pile falsework for the bridge. The trestle carried a track of 8-ft. gage on which

TABLE II — ITEMS THAT MADE UP THE TWO LOWEST BIDS

Item	Quantity	Portland Dredging Co. (unit prices in dollars;		Hagman & Larson (unit prices in dollars)	
Structural steel	3,811 lb.	0.10		0.12	
Structural excavation for piers	970 cu. yd.	10.00		9.00	
Lumber railing	7M ft. b. m.	80.00		90.00	
Concrete class *A*	1,219 cu. yd.	23.50		30.00	
Concrete class *B*	82 cu. yd.	15.00		16.00	
Concrete class *D*	379 cu. yd.	11.00		17.00	
Copper seal	44 lin .ft.	1.00		1.00	
Reinforcing steel	330,178 lb.	0.045		0.045	
Drive peeled fir piles	80	7.00		9.00	
Furnish peeled fir piles	1,440 lin. ft.	0.15		0.20	
Remove existing structure	671 lin. ft.	2.54		6.00	
Total Bid on Bridge Items			$62,068.95		$74,078.33
Unclassified Excavation	8,800 cu. yd.	0.15		0.30	
Structural Excavation for Culverts and Riprap	45 cu. yd.	1.50		2.00	
Riprap Class *B*	200 cu. yd.	5.25		2.75	
Crushed Rock Surfacing Type B-Top	330 cu. yd.	4.00		2.75	
Crushed Rock Surfacing Type B-Bottom	330 cu. yd.	4.00		2.75	
18" Std. Reinforced Concrete Pipe	100 lin .ft.	2.00		2.00	
Overhaul	13,200 cu.yd. mi.	0.20		0.12	
Total Bid on Other Items			$7,917.50		$6,879.00
Total Bid			$69,986.45		$80,957.33

was operated a crane with a long boom. With this crane the contractor drove and pulled sheetpiling, excavated piers, handled the caged reinforcement of the pier shafts and swung into place the long 2-in. square bars used in the box girders. This crane also served in the placement of all concrete. A small mixer with caterpillar treads operated over the construction trestle, receiving batched aggregates hauled from bunkers about 5 mi. away.

The mixer discharged into a bottom-gate bucket which was swung by the crane directly to the point of discharge—to the hopper at the head of the tremie tube by which the footings were found, to the webs of the box-girders, to the roadway slab, or to the curb, as required. The bucket gate worked effectively in controlling discharge and two or three men could swing the bucket slightly from its free hanging position to locate it exactly where wanted. This made it unnecessary to handle any concrete in buggies over runways.

The crane also placed and removed the inner forms for the box-girders. These were made up in large sections in a work yard on the gravel spit and were used twice. Only the forms for the underside of the roadway slab were left within the box girders. All forms were lined with plywood, except the bottom and inner surfaces, of the box-girder. The final service performed by the crane was removal of the construction trestle.

The sequence of concreting operations was footings, pier shafts from footings to girder haunches, everything in the deck below roadway slab from expansion joints to end of bridge, roadway slab within the same limits, and, finally, curbs within the same limits. The western part of the bridge was completed first, then the eastern part; the central span with the suspended portion came last of all.

The greatest yardage and consequently the longest continuous pour was that of the girder webs, cross diaphragms and soffit slab for the 225-ft. sections extending from the expansion joints to the ends of the bridges. When this pour of the westerly portion was undertaken, concreting began at the extreme westerly end and proceeded upgrade toward the expansion joint. A point about 25 ft. east of the end pier, and an equal distance into the 140-ft. span had been reached, when a very heavy rain stopped the work.

When the job was thus shutting down, the end of the pour in the bottom slab was brought to a perpendicular plane extending squarely across the girder, but in the 8-in. webs the concrete sloped from bottom to top in a distance of about 10 ft.; i.e. at the bottom of the webs it was about 30 ft. from the pier center line; at their tops about 20 ft. Since there were numerous stirrups in this zone making the surface of the concrete irregular and since the general direction of the joint was almost squarely perpendicular to the direction in which shear cracks in the webs would develop, no additional precautions were taken, such as forming steps or key-ways in the surface, or providing additional reinforcement across the joint.

Load test required

The omission of these conventional safeguards resulted in a request from

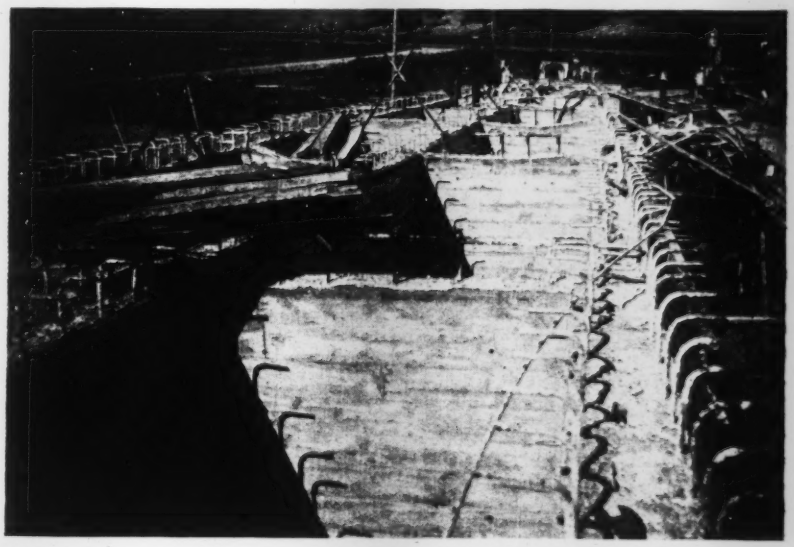

Fig. 4. The easterly 140-ft. girder after removal of forms from longitudinal and transverse webs. The latter are 8 in. thick spaced 17 to 20 ft. apart.

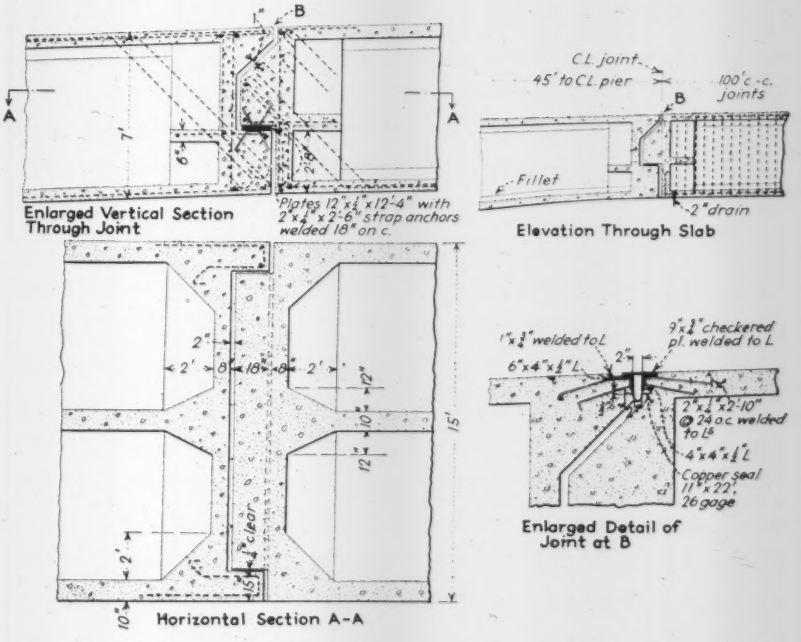

Fig. 5. Vertical and horizontal section of the interlocking joint.

the State Highway Department that a test load be applied at this joint, to produce in the webs a live load shear double that for which they were designed. Consequently, after wedges were struck and the bridge was self-supporting, a box 20 ft. square and 6 ft. deep was built on the deck and was filled with pit run sand and gravel—a load of 115 tons, which was left in place for 12 hr. At various times during the filling of the box, readings with an extensometer graduated to 0.0001 in. were taken across the joint on plugs previously set in the outer webs at an angle of about 36 deg. with the joint. The final reading, after the 12-hr. period of load application, showed zero movement. The cantilever slabs adjacent to the sand box were watched closely to see whether this load (575 lb. per sq. ft.) produced any distress. None was observed.

Accurate levels were taken over the bridge before and after removal of the falsework, the second reading being subsequent to removal of the test load. Settlement and deflection combined were as shown in Table I.

As the bridge was built with gas tax money received from the state, the design was checked by the bridge division of the State Highway Department; it conforms to *A.A.S.H.O.* specifications for *H*-15 loading. Maximum working stresses used were: concrete 1,000 lb. per sq. in.; steel 18,000 lb. per sq. in.; shear 180 lb. per sq. in.

Major features of the layout were suggested by H. M. Hadley, regional structural engineer, Portland Cement Association. The detailed design was prepared by W. H. Witt Company of Seattle. The writer is engineer of Pierce County; W. H. Craft was resident engineer in charge of construction. The contractor, who deserves commendation for exceptionally good concrete work, was the Portland Dredging Co., Portland.

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WPA in Chicago

In 1937 WPA in Chicago demolished 3,091 condemned buildings, cleared 27,920 vacant lots for playgrounds, laid 267 miles of street pavement and 1,200,000 sq. yd. of sidewalk, repaired 10,000 water leaks, removed 15,000 trees and increased the corner curb radius at 4,250 points.

Analyzing Flow in Pipe Networks

by Gordon M. Fair

Gordon McKay Professor of Sanitary Engineering, Harvard University, Cambridge Ma

A simplified approach to the application of the Hardy Cross method of flow analysis in a water system

The Hardy Cross method of computing the flow distribution and variation of head in various parts of a pipe network is a new and valuable engineering tool. Its application to waterworks practice, first described by Prof. Doland, University of Illinois, in Engineering News-Record *a year and a half ago, is simplified by the technique set forth by Prof. Fair of Harvard University.* — Editor.

The method developed by Hardy Cross for the analysis of flow in networks of conduits or conductors (*Bull.* 286, Univ. of Illinois, 1936) was applied to the solution of a typical water supply distribution problem by J. J. Doland in an illustrative example published in *ENR*, Oct. 1, 1936, p. 475. In order to employ the Hazen and Williams formula, Prof. Doland found it convenient to develop two tables not ordinarily accessible to engineers. It is possible, however, to employ instead of these tables the original Williams and Hazen tables, the Hazen and Williams slide rule, or a diagram of the Williams and Hazen formula. One of these is generally available to engineers. It is possible, furthermore, to reduce the incidental burden of calculation by so doing and thus to encourage the use by engineers of Prof. Cross' admirable method of analysis.

The Hardy Cross analysis is based upon successive approximations of the flow distribution in a network by applying corrections to assumed and subsequently corrected flows until the head loss between points of divergent and convergent flow is balanced.

For example, in the simple network of flow distribution shown in Fig. 1, let Q equal the total flow into the system and Q_o and Q'_o; where $Q_o + Q'_o = Q$, the assumed flows in each branch. If the assumed flows were correct, the loss of head h_o associated with the flow Q_o should equal the loss of head h'_o

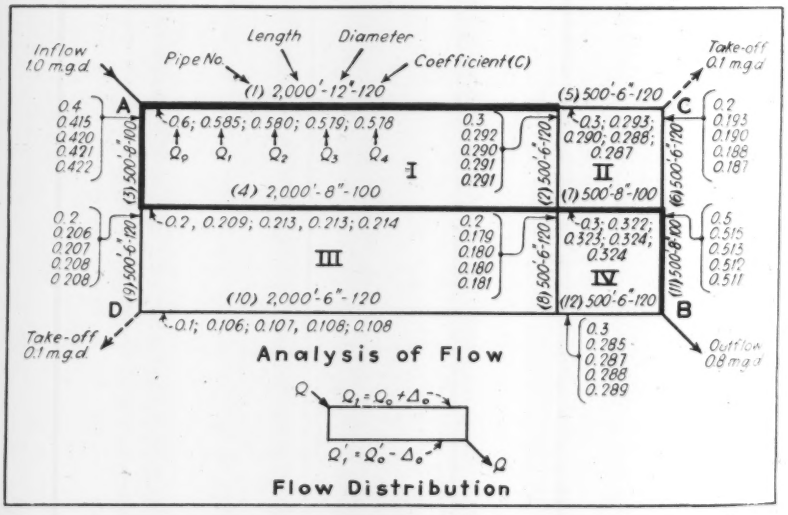

Fig. 1. **Typical network problem illustrating the application of the Hardy Cross method of analyzing flow distribution.**

associated with Q'_o, or $h_o - h'_o = O$.

In the Williams and Hazen formula:

$$Q = av = \frac{\pi d^2}{4} C \left(\frac{d}{4}\right)^{0.63} \left(\frac{h}{l}\right)^{0.54} 0.001^{-0.04}$$

$$\text{and } h = \left(\frac{0.001^{0.04}}{C} \times \frac{4^{1.63}}{\pi} \times \frac{l^{0.54}}{d^{2.63}}\right)^{1.85} Q^{1.85}$$

$$\text{or } h = kQ^{1.85} = kQ^n$$

Here d is the diameter of the pipe, l its length and C its coefficient of discharge.

If the assumed flows Q_o and Q'_o are not correct by an amount Δ_o and the corrected flows are respectively,

$$Q_1 = Q_0 + \Delta_0 \text{ and } Q'_1 = Q'_0 - \Delta_0$$

$$\text{Then } h_0 - h'_0 = k(Q_0 + \Delta_0)^n - k'(Q'_0 - \Delta_0)^n = O$$

$$\text{or } k(Q_0^n + n\,\Delta_0 Q_0^{n-1} + \ldots.)$$
$$-k'\,(Q'_0{}^n - n\,\Delta_0\,Q'_0{}^{n-1} + \ldots.) = O$$

If Δ_o is small compared with Q_o and Q'_o the remaining terms of the expansion may be neglected. Solving for Δ_o,

$$\Delta_0 = -\frac{kQ_0^n - k'\,Q'_0{}^n}{nkQ_0^{n-1} + nk'Q'_0{}^{n-1}}$$

or generalized,

$$\Delta_0 = -\frac{\Sigma kQ_0^n \text{ (with attention to flow direction)}}{n\,\Sigma kQ_0^{n-1} \text{ (without reference to flow direction)}} \quad (1)$$

Since

$$kQ_0^n = h_0 \qquad \text{and } kQ_0^{n-1} = \frac{h_0}{Q_0}, \quad \Delta_0 = -\frac{\Sigma h_0}{n\Sigma\,\dfrac{h_0}{Q_0}} \quad (2)$$

If a positive sign is assigned arbitrarily to flow and loss of head in a clockwise direction, and a negative sign to flow and loss of head in a counterclockwise direction, equation (2), unlike equation (1), will be inherently consistent in an algebraic sense. It is the development of equation (2) that leads to the simplified application of the Hardy Cross method.

The correction Δ_o is applied to the assumed flows and yields the first corrected flows Q_1. If these do not balance the system, correction Δ_1 is determined; subsequent corrections are made until the system is properly balanced.

Application of the Hardy Cross method to the analysis of a pipe network (Fig. 1), calculation of which is difficult or laborious by other means, is illustrated in the accompanying table. The first correction changes the flows by a maximum of 10.5 per cent; the second correction by 1.9 per cent; the third by 0.9 per cent and the fourth by 0.5 per cent. The latter carries the analysis as far as is warranted by the precision of common methods of calculation.

For an inflow of 1 m.g.d. and take-offs of 0.1 m.g.d. at C and D, the head loss between points A and B by any possible path is found to be 6.41 ft. For an entrant flow other than 1 m.g.d., the flow through each pipe will vary in proportion to the entrant flow, providing the take-offs vary in the same proportion.

TABLE I — CALCULATIONS OF SUCCESSIVE APPROXIMATIONS USED FOR THE ANALYSIS OF FLOW DISTRIBUTION IN THE NETWORK SHOWN IN FIG. 1

Net Work: Circuit No.	Pipe No.	Length 1,000 ft.	Diam. in.	C	Assumed Flow: Q_0 m.g.d.	s_0 1/1000	h_0 ft.	$\frac{h_0}{Q_0}$	Δ_0 m.g.d.	First Correction: Q_1 m.g.d.	s_1 1/1000	h_1 ft.	$\frac{h_1}{Q_1}$	Δ_1 m.g.d.	Second Correction: Q_2 m.g.d.	s_2 1/1000	h_2 ft.	$\frac{h_2}{Q_2}$	Δ_2 m.g.d.	Third Correction: Q_3 m.g.d.	s_3 1/1000	h_3 ft.	$\frac{h_3}{Q_3}$	Δ_3 m.g.d.	Result: Q_4 m.g.d.	s_4 1/1000	h_4 ft.
I	1	2.0	12	120	+0.6	0.58	+1.16	1.93	−.015	+0.585	0.56	+1.12	1.92	−.005	+0.580	0.54	+1.08	1.86	−.001	+0.579	0.54	+1.08	1.87	−.001	+0.578	0.54	+1.08
	2*	0.5	6	120	+0.3	4.70	+2.35	7.83	−.015	+0.292	4.47	+2.23	7.64	−.005	+0.290	4.42	+2.21	7.62	−.002	+0.288	4.43	+2.21	7.63	−.001	+0.291	4.43	+2.21
	3	0.5	8	100	−0.4	2.70	−1.38	3.45	−.015	−0.415	2.96	−1.48	3.57	−.005	−0.420	3.03	−1.52	3.62	−.001	−0.421	3.05	−1.53	3.64	−.001	−0.422	3.07	−1.54
	4*	2.0	8	100	−0.2	0.77	−1.54	7.70	−.015	−0.209	0.84	−1.68	8.04	−.006	−0.213	0.86	−1.72	8.07	−.001	−0.213	0.86	−1.72	8.07	−.000	−0.214	0.87	−1.74
					+0.59	+20.91	x 1.85 = +0.015			+0.19	+21.17	x 1.85 = +.005			+0.05	+21.17	x 1.85 = +.001			+0.05	+21.21	x 1.85 = +0.001					+0.01
II	5	0.5	6	120	+0.3	4.70	+2.35	7.83	−.007	+0.293	4.53	+2.27	7.75	−.003	+0.290	4.42	+2.21	7.62	−.002	+0.288	4.40	+2.20	7.63	−.001	+0.287	4.35	+2.17
	6	0.5	6	120	+0.2	2.22	+1.11	5.55	−.007	+0.193	2.09	+1.05	5.44	−.003	+0.190	2.03	+1.02	5.37	−.002	+0.188	1.99	+1.00	5.32	−.001	+0.187	1.96	+1.00
	2**	0.5	6	120	−0.3	4.70	−2.35	7.83	−.007+.015	−0.292	4.47	−2.23	7.64	−.003+.005	−0.290	4.42	−2.21	7.62	−.002+.001	−0.291	4.43	−2.21	7.59	−.001+.001	−0.291	4.43	−2.21
	7*	0.5	8	100	−0.3	1.62	−0.81	2.70	−.007−.015	−0.322	1.85	−0.93	2.89	−.003+.002	−0.323	1.87	−0.94	2.91	−.002+.001	−0.324	1.88	+0.94	2.90	−.001+.001	−0.324	1.88	−0.94
					+0.30	+23.91	x 1.85 = +0.007			+0.15	+23.72	x 1.85 = +.003			+0.08	+23.52	x 1.85 = +0.002			+0.05	+23.44	x 1.85 = +0.001					0.00
III	4**	2.0	8	100	+0.2	0.77	+1.54	7.70	−.006+.015	+0.209	0.84	+1.68	8.04	−.001+.005	+0.213	0.86	+1.72	8.07	−.001+.001	+0.213	0.86	+1.72	8.07	−.000+.001	+0.214	0.87	+1.74
	8**	0.5	6	120	+0.2	2.22	+1.11	5.55	−.006−.015	+0.179	1.82	+0.91	5.08	−.001+.002	+0.180	1.83	+0.92	5.11	−.001+.001	+0.180	1.83	+0.92	5.11	−.000+.001	+0.181	1.85	+0.92
	9	0.5	6	120	−0.2	2.22	−1.11	5.55	−.006	−0.206	2.36	−1.18	5.73	−.001	−0.207	2.37	−1.19	5.75	−.001	−0.208	2.40	−1.20	5.77	−.000	−0.208	2.40	−1.20
	10	2.0	6	120	−0.1	0.61	−1.22	12.20	−.006	−0.106	0.69	−1.38	13.02	−.001	−0.107	0.70	−1.40	13.08	−.001	−0.108	0.72	−1.44	13.33	−.000	−0.108	0.72	−1.44
					+0.32	+31.00	x 1.85 = +0.006			+0.03	+31.87	x 1.85 = +.001			+0.05	+32.01	x 1.85 = +.001			+0.00	+32.28	x 1.85 = +.000					+0.02
IV	7**	0.5	8	100	+0.3	1.62	+0.81	2.70	−.007	+0.322	1.85	+0.93	2.89	−.002+.003	+0.323	1.87	+0.94	2.91	−.001+.002	+0.324	1.88	+0.94	2.90	−.001+.001	+0.324	1.88	+0.94
	11	0.5	8	100	+0.5	4.18	+2.09	4.18	+.015	+0.515	4.42	+2.21	4.29	−.002	+0.513	4.40	+2.20	4.29	−.001	+0.512	4.38	+2.19	4.28	−.001	+0.511	4.37	+2.19
	8**	0.5	6	120	−0.2	2.22	−1.11	5.55	+.006	−0.179	1.82	−0.91	5.08	+.001	−0.180	1.83	−0.92	5.11	+.001	−0.180	1.83	−0.92	5.11	+.000	−0.181	1.85	−0.92
	12	0.5	6	120	−0.3	4.70	−2.35	7.83	+.015	−0.285	4.30	−2.15	7.55	+.002	−0.287	4.34	−2.17	7.56	+.001	−0.288	4.38	−2.19	7.61	+.001	−0.289	4.40	−2.20
					−0.56	+20.26	x 1.85 = −0.015			+0.08	+19.81	x 1.85 = +.002			+0.05	+19.87	x 1.85 = +.001			+0.02	+19.90	x 1.85 = +0.001					+0.01

* Pipe serves more than one circuit; first consideration of this pipe.
** Second consideration of this pipe.
† = loss of head in ft. per 1,000 ft. of pipe.

† Corrections in this column are those calculated for same pipe in the companion circuit; they are of opposite sign.

$$\Delta = -\left(h + n\,s\,\frac{h}{Q}\right)$$

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

Jack Setup for Pile Test

by RUSSELL C. BIMKER

University of Hawaii, Honolulu, T. H.

A simple yet novel method of testing the load-bearing power of a pile is used by government engineers on the Mississippi River lock and dam construction work. The load is applied by a hydraulic jack pressing down upon a steel plate resting on the pile. The upward push of the jack is resisted by a 30-in. beam which pulls against cables looped over steel bearing blocks on the beam, and fastened to steel castings which fit in holes cut through reaction piles, which are about 6 ft. c. to c. The cables are boxed in during the test period as a protection to workmen in the event of a cable snapping under load. Buckling of the beam web is prevented by stiffeners over the jack, and under the bearing blocks supporting the cables. The action is compression on the center or test pile, and a pull on the end piles.

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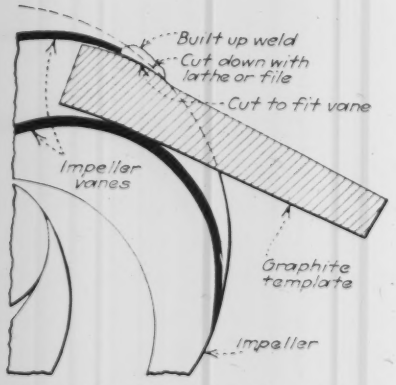
Welding Impeller-Vane Tips

by DANIEL MCFARLAND

Mason City, Wash.

At the Grand Coulee dam the contractor has about 80 small sump pumps that are used to pump concrete-cleanup water, which contains much abrasive sand and cement. This quickly wears out the impellers at the ends of the vanes. To salvage the worn impeller the pump-repair man built up the vane by welding material onto it and then finishing it off smooth. It was easy to finish the outer side of the curve but very difficult to finish the inside so he conceived the idea of making a template for the inner surface so that he would not have to finish it. He found that graphite or hard carbon suited the purpose for the following reasons: It would stand the heat; the metal would not stick to it; and it is easy to shape to the required curve. The graphite is first shaped and then held in place using the back of the next vane for a fulcrum. The vane is then built up with welding rod and the excess metal is cut off to make a smooth job. This latter may be done in a lathe or if that is not handy the impeller is put in the pump and a file used as the cutting tool as the pump motor turns the pump. A manganese-bronze welding rod is used. This is a little harder than the bronze in the impellers, so that the rebuilt ones sometimes outlast the new ones. The cost of rebuilding is about $2 compared to a new cost of $18. This same idea can be applied to other straight, curved or irregular surfaces. The credit for it belongs to Victor Esser of the contractor's force.



Device for welding new tips on worn sump impeller vanes

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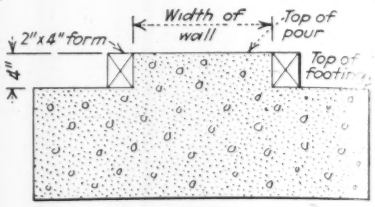
Upset on Footings

by WILLIAM T. WRIGHT

Structural Engineer, Los Angeles, Calif.

The detail shown for the top of footings has been found to be very helpful, especially where footings are in deep trenches. The side form of the upset portion is usually made with a 2x4-in. piece. The advantage of the detail is that in cleaning the forms before placing concrete in the walls above, the water will readily drop away from the surface being cleaned. Also in constructing the wall forms, the upset portion provides a surface against which the forms can be tightened, thus insuring the proper starting of wall forms above the footing level.



Footing with upset facilitates erection of wall forms

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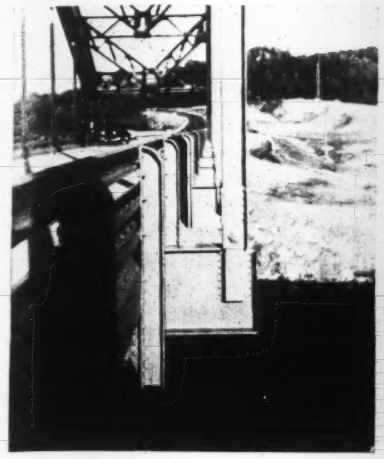
Brief Memoranda

The overburden at the Grand Coulee Dam is a dense bluish-black clay which has great cohesive powers. It was excavated with large shovels, loaded into trucks or crawler wagons and dumped on a grizzly, which was the first step in taking it for a ¾-mi. ride on a belt conveyor. During the cold weather the principal problem was to get the clay out of the trucks and wagons, as it froze to the steel bodies. After trying several expedients, a small tractor was made into a home-made bulldozer with a long thin blade. When the trucks got too badly stuck up with clay they were taken to a special dump and after raising the truck to the dumping position the bulldozer would scrape the clay loose. This was used until the warm weather made it unnecessary. — DANIEL MCFARLAND, *Mason City, Wash.*

When drilling anchor-bolt holes in concrete piers or abutments, the drill not infrequently is deflected from the correct location by striking the side of a reinforcing bar or hard piece of coarse aggregate. A simple and effective way of keeping the drill on the correct line is merely to place a few cast iron or steel chips in the hole, and resume drilling.— THEODORE DOLL, *Engineering Department, C.M.St.P. & P.R.R., Chicago, Ill.*

It is desirable to have a thickened edge on road-mix and other asphalt surfaces, especially on thin flexible bases of gravel. This can be easily and economically accomplished on such bases by tilting the blade of the grader so as to cut a trench about



CAMERA MEMORANDA

1—In working out the details of the new 425-ft. steel arch that replaces the old Brattleboro, Vt., suspension bridge destroyed by the Connecticut River flood of 1936, this railing post was designed. The web of a steel I-beam is cut out and the outside flange is curved over to a connection with the inside flange to form a neat post top. Incidentally, take notice of the pin-connected hangers.

2—Looking up underneath on the same bridge an ample and economical down-spout for draining the deck was made of channels and plates.

3—And finally, on the approaches the transition illustrated was provided between the rails on the bridge and the guard rails on the approach embankments.

The Brattleboro arch was designed and built under the direction of the New Hampshire highway department.

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2 ft. wide, and 2 in. deep at the outer edge, allowing the trench to taper out to a feather edge on the inside. This practice provides desirable additional strength at the most vulnerable areas of the surface, and also provides means by which the edges may be constructed with good alignment. The excavated material forms an excellent shoulder, also serving to strengthen the shoulder and to protect the newly-constructed surface, preserving the alignment as well as providing a runoff to eliminate surface water quickly. — W. R. MACATEE, *District Engineer, Asphalt Institute, Cincinnati, Ohio.*

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Closure of Levels Circuit

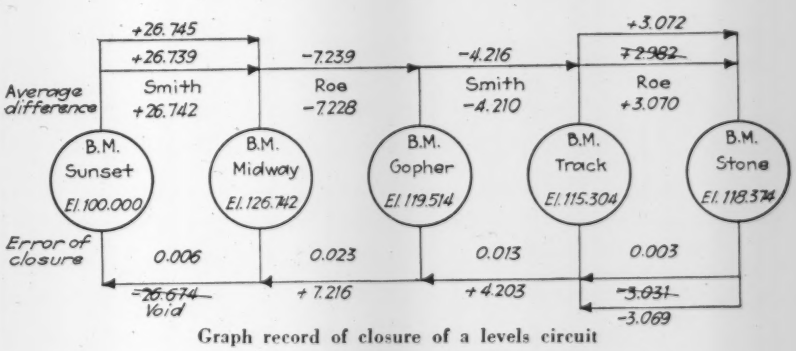
by RUSSELL C. BIMKER

University of Hawaii, Honolulu, T. H.

The adjustment of a line of differential levels is covered sparingly, if at all, in most surveying texts. The customary procedure for such a line of levels is to add the difference in elevation found from two runs between the starting B.M. *A* and the succeeding B.M. *B*. While relatively simple, the question of signs (whether to add or subtract a difference) bothers practicing engineers as well as students of civil engineering.

A graphical method of analysis has been developed at the University of Minnesota to provide a self-explanatory picture of the field data, and avoid errors in the reduction of notes. In the graph, the elevation of B.M. Sunset is placed in a circle, and the difference in elevation between B.M. Sunset and B.M. Midway on the run out equal to +26.739 ft., and on the run back equal to —26.674 ft. are noted as shown. The direction of run is indicated by an arrow. Since the error of closure for the loop was more than the 0.030 allowable for this case, another run was made, and the result +26.745 tabulated. The average difference in elevation is, then, +26.742, the sign being that of the value for the run out. Adding this difference to the elevation of B.M. Sunset gives the elevation of B.M. Midway. The error of closure and the name of the instrument man are also listed. The graphical analysis thus shows at a glance all the important data, i.e., B.M. elevations and differences in elevations, and the error of closure for each loop.

In the field notes, elevations may be assumed for B.M.'s and the analysis completed for these values. To reduce the elevations to any other datum plane then requires only the addition or subtraction of a constant.



Graph record of closure of a levels circuit

Notes on Sewage Disposal

A monthly summary of current developments conducted by Willem Rudolfs

TYPHOID BACTERIA — Evidence exists showing that typhoid organisms remain viable for comparatively long periods in clean and polluted waters as well as in sewage. Studies on the death rate of typhoid organisms in an operating trickling filter were recently reported by Beard (*Jour.* A.W.W.A. Jan. 1938). Dosing at rates of 6.6 m.g. a.d. (constant dosing) provided a 99 per cent reduction in typhoid organisms while the B.O.D. reduction amounted to 80 per cent. When the dosage was raised to 12 m.g.a.d. the reduction of typhoid organisms was 95 per cent. With intermittent dosing at a rate of 1 m.g.a.d. (2 min. dosing and 6 min. resting) using 5.5 million typhoid organisms per c.c., there were never more than 30 typhi per cubic centimeter in the effluent. At a dosing rate of 2.8 m.g.a.d. a reduction of 99 per cent was indicated. However, even with such a high reduction a considerable number of organisms was left in the effluent.

SEEDING DIGESTERS—The possibility of using rotted leaf mold as seed material to start digesters was reported previously. Recent experiments conducted by Lesenyei (*Gesundheits Ingenieur*, 60, 731, 1937) at Budapest, who used this material with sewage sludge, screenings and kitchen waste seem to indicate that the leaf mold is slightly less effective than digested sludge, but is useful in starting of digesters when no other material is available. Variations in gas production caused by increasing quantities of screenings or garbage was greater than that caused by the inoculum.

REMEDY FOR SLUDGE RISING— Plant operators find that "blanket rising" of activated sludge in the final tanks may occur when sludges are highly nitrified and when sludge is stale. Lockett (*The Surveyor* Dec. 10, 1937) comes to the conclusion that the requirements to prevent sludge rising troubles are: (1) thorough conditioning or activation of sludge in mixed liquor channels before passing the liquor into the final tanks; (2) continuous flow treatment in an aeration tank so designed as to eliminate short-circuiting; and (3) reduction of detention in the final tanks to a minimum since all nitrifying sludges have a tendency to rise after several hours of non-aeration.

EXPRESSING RIVER CLEANUP— It is difficult for the layman to appreciate improvements brought about in streams after sewage plants have gone in operation, unless pollution abatement can be expressed in easily understood terms. Several ways have been used to express decrease in pollution load, one of the common methods being to calculate the amount of solids removed in tons. When the removal of sludge and other oxygen-demanding substances are calculated in terms of equivalent pounds of pure oxygen, however, the results are rather imposing. Since this oxygen requirement must be supplied by the river water, and the water contains usually from 6 to 9 p.p.m. or from 50 to 75 lb. of oxygen per million gallons of water, the removal of oxygen-demanding substances can be expressed in volumes of clean water.

Some calculations were recently made on this basis for the Elizabeth, Rahway and Raritan rivers in New Jersey where new plants have gone into operation. These showed that the Elizabeth plant removes daily an estimated minimum of 12,000 cu.ft. of wet sludge, equivalent to about 21,000 pounds of oxygen or to the amount of oxygen available in some 200 or 300 m.g. of clean water daily. Similar calculations for the Rahway Valley plant showed removal of some 3,600 cu.ft. of wet sludge and a reduced pollution load equivalent to 42-55 m.g. of clean water. On the Raritan River, where several new plants have been placed in operation, the amount of wet sludge prevented from reaching the stream is estimated to be some 125 tons daily, equivalent in oxygen content to that carried in 90 to 120 m.g. of clean water daily. With this kind of information the layman obtains a much clearer picture of accomplishment than that provided when percentages of suspended solids removal and biochemical oxygen demand reduction are given.

TRICKLING FILTERS — Experimental work in this country some years ago dealing with the value of closed trickling filters as compared with the open type indicated that purification in the closed filter was somewhat higher than in the open type with the additional advantage of absence of flies. Forced draft filters have also been studied abroad where the results obtained were uniformly better than those obtained with open filters. Results from a full scale plant, operated for a number of months at Johannesburg, South Africa, were recently presented by Hamlin and Wilson (*The Surveyor*, Dec. 30, 1937 and Jan. 7, 1938). At this place part of the sewage was treated on enclosed and part on open filters along similar lines as far as diameter, filtering media and sprinkler were concerned. The enclosed type was 15 ft. deep as against 5 ft. 6 in. for the the open type. The liquid passed through the enclosed filter was 2½ times greater than through the open filter.

The sewage of Johannesburg is strong and difficult to treat, contains various trade wastes, and arrives at the plant in a septic condition. The following is an average of analyses on the effluent:

	Open filter	Enclosed filter
Oxygen absorbed (4 hr.)	43.0 p.p.m.	52.9 p.p.m.
Ammoniacal—N	38.7 "	43.1 "
Nitrate—N	1.7 "	5.0 "
Nitrate—N	6.5 "	17.0 "
B. O. D.	35.6 "	34.5 "
Relative stability	68.7%	98.1%

The cost of construction of the much deeper enclosed filter and the royalties to be paid for the process appear to indicate that much further work is needed before this system is able to replace the conventional open filter.

THE WEEK'S EVENTS

(Continued from page 321)

Freeze Ground Around Gilbertsville Test Pit

Freezing the ground around the big test shaft at the Gilbertsville Dam site is being undertaken to halt an inflow of groundwater which has interfered with the sinking of the shaft. Preparations for the freezing operation were completed last week.

The test shaft was begun several months ago and is to be sunk about 95 ft. to bedrock. Measuring 20 ft. in diameter, it is constructed of interlocking steel sheet piling. TVA engineers felt that the size of the dam contemplated at Gilbertsville warrants the unusual precaution of driving this size of test shaft at an early stage of the investigation.

Excavation within the cell had proceeded to within 14 ft. of bedrock when the inflow of groundwater became so great as to force silt through the caulked seams between the piling. It was then decided to install a refrigerating plant and freeze the area around the cell. This method is widely used in Europe to protect deep coal mine shafts from water and was used for shafts at the Antwerp Tunnel. Refrigeration methods were used at the Grand Coulee project to prevent landslides.

At the Gilbertsville site, about 30 pipes are being placed vertically in the ground at 30 in. intervals around the outside of the test shaft extending down to bedrock. Cold brine continuously re-chilled by an ammonia cooling system will be circulated through the system of pipes. With the subsoil frozen solid for several yards around the shaft, excavation can then continue unimpeded.

OBITUARY

JULES A. DUCHASTEL DE MONTROUGE, who was appointed treasurer of the Engineering Institute of Canada a few weeks ago, died in Montreal Feb. 20 at the age of 60. Educated in France, Holland and Canada, Mr. Duchastel graduated in 1901 from Ecole Polytechnique in Montreal and spent the next few years in engineering work on the Canadian Pacific Ry. In 1906 he was appointed chief engineer of the town of Outremont, one of the two residential municipalities which are completely surrounded by the city of Montreal, and he held this post and later that of city manager until 1924. He then became manager of the Quebec Forest Industries Association, serving in that capacity until 1936, when he was appointed assistant general manager of the port of Montreal under the National Harbor Board.

GEORGE E. CHAPIN, civil engineer of the Malden (Mass.) Electric Co. and of the Malden & Melrose Gas Light Co., died in Boston Feb. 19 at the age of 67. He graduated from the Massachusetts Institute of Technology in 1894 and was employed for some years by the Brooklyn Rapid Transit Co. before going to Malden.

JOSEPH J. PETERKA, SR., a civil engineer in the Cleveland Street Department for 28 years, died there recently at the age of 57. He was a graduate of Case School of Applied Science and Ohio State University.

WILLIAM A. LAMB, 56, district engineer for the U. S. Geological Survey in Montana, North Dakota and South Dakota, died at Helena, Mont., Feb. 10. Mr. Lamb, a graduate of the Colorado State College in 1903, taught there for a year and a half and then joined the Geological Survey. He spent two years on reservoir surveys and stream gaging in Colorado and Oklahoma, was for a year district hydrographer in Oklahoma, Texas and New Mexico, and then assistant engineer on water resources investigation in California. After a year as first assistant to the district engineer in the South Atlantic States and the Upper Mississippi River district, he was put in charge of the Missouri River district, which then included Montana, northern Wyoming and North Dakota, in 1909.

SAMUEL B. DINSMORE, 51, district maintenance supervisor of the Washington State Highway Department at Bremerton, died there Feb. 5. Mr. Dinsmore, connected with the highway department for many years, and been a supervisor since last August.

WILLIAM H. EAGLE, a civil engineer in the service of the city of Columbus since 1905, died there Feb. 13 at the age of 65. Mr. Eagle was a graduate of Ohio State University, and began work for the city while in his senior year at the University.

WARD W. CLAFLIN, for 29 years architect and engineer of the New York

HYDRO PLANT IN MAINE

THIS NEW 9,000-hp. hydro-electric plant of the Cumberland County Power & Light Co. will soon be placed in service on the Saco River at Saco, Me. The 90-ft. long dam on rock foundations will create a head of 44 ft. A 20-ft. wide crest gate, of the motor operated type, is provided, and besides two headgates the plant will have two tailgates to prevent tidewater back-up when it is necessary to inspect or repair the waterwheel. The plant will be operated by remote control from a substation on the river bank above the station. The New England Public Service Company of Augusta, Maine, acted as consultant on the job.

State Building and Housing Commission of Brooklyn, died in East Orange, N. J., Feb. 8, at the age of 57.

FLOYD J. BEEGHLEY, 37, resident engineer at Phoenix for the Arizona state highway department, died there Jan. 26. Mr. Beaghly had been in the engineering division of the highway department since 1923; during the past few years he had been in charge of WPA work for the highway department in southern Arizona.

DAVID E. MCELROY, architect for the Metropolitan Life Insurance Co., died recently in New York City at the age of 43. He was formerly a member of the engineering firm of John E. Kleist & Associates.

WARREN WITHEE, assistant district engineer for the U. S. Geological Survey at Chattanooga, died in Nashville, Feb. 3. Mr. Withee had been connected with the Chattanooga office since its establishment in 1920.

BRIEF NEWS

REGULATION of the flow of the 1,100-mile Orange River is to be undertaken by the South African government. The cabinet has agreed on the necessity to build an impounding dam to cost about $5,000,000. The irrigation department will soon select a suitable site for the dam.

A GENERAL PLAN for the central part of the city of Ottawa, estimated to cost about $30,000,000 and to take from 25 to 50 years to complete, has been given general approval by the federal government of Canada. The plan was developed by Jacques Greber, French architect and town planner, who was retained by the Canadian government for the purpose. The federal department of public works has announced that first steps toward putting the plan under way will be taken within the next few months with the erection of the Canadian National War Memorial on a central site and demolition of the old post office building. Some street widening will also be undertaken at an early date.

THE FEDERAL POWER COMMISSION has denied an application for a preliminary permit and license for two hydroelectric plants, with 12,000 hp. capacities each, to utilize surplus water at existing federal dams in the Des Plaines River at Brandon Road and in the Illinois River at Dresden Island, Ill. The state of Illinois has protested against issuance of a license for the project, on the ground that it is not adequately financed.

A MOTION PICTURE, "Conquest of the Hudson", showing the construction of the Lincoln Tunnel has been produced by the Port of New York Authority. Scenes show the tunnel shield, sandhogs in the airlocks, holing through and other major operations, while narration describes the action. The Port Authority states that prints are available upon request in 16 mm. and 35 mm. size, without charge to organizations.

A VOLUNTARY craft training school for WPA workers has been organized in Arizona under the direction of the Phoenix chapter of the American Association of Engineers. A 64-man board has been formed by the chapter to outline courses of study; these were formulated in consultation with employers in order to provide the types of training needed in industry. Teaching will be done by WPA teachers. Classes begin in February at the state teachers college at Tempe, and classes will be started later at other points in the state.

DR. HUGH E. VALIN, medical director of the U. S. Public Health Service at London, has been named as the American delegate to the 49th Congress of the Royal Sanitary Institute, which will be held at Portsmouth, England, July 11-16. The United States has participated in these congresses for a number of years.

FOUNDATIONS have been completed for the Palace of Soviets in Moscow, which will be the tallest building in the world. Foundation construction presented a difficult problem because much of Moscow, including the area on which the Palace of the Soviets will stand, is built over what was once swampy ground.

PLANS for a 28-story office building estimated to cost about $10,000,000 have been filed with the New York City Department of Housing and Building by the Metropolitan Life Insurance Co. The new structure would be built on the same block as the company's present building erected in 1932.

BEDROCK conditions favorable for construction of a dam were revealed by the first test core sunk at the site of the proposed Cabinet Gorge dam on the Clark Fork River in Idaho, according to W. G. Sloan, in charge of the survey for the Bureau of Reclamation. A survey of possible power markets in the near vicinity also is being carried on.

CALENDAR OF MEETINGS

NATIONAL SOCIETIES

AMERICAN SOCIETY FOR TESTING MATERIALS, regional meeting, March 9, and committee week, Seneca Hotel, Rochester, N. Y., March 7-11.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, annual meeting, Chicago, March 15-17.

BUILDING OFFICIALS CONFERENCE OF AMERICA, annual meeting. Willard Hotel, Washington, March 21-25.

AMERICAN SOCIETY OF CIVIL ENGINEERS, Spring meeting, Jacksonville, Fla., April 20-23.

AMERICAN SHORE & BEACH PRESERVATION ASSOCIATION, annual meeting, Washington, D. C., April 19, and Jacksonville, Fla., April 21.

AMERICAN WATER WORKS ASSOCIATION, annual convention, Roosevelt Hotel, New Orleans, April 24-28.

REGIONAL AND LOCAL

IOWA ENGINEERING SOCIETY, annual meeting, Iowa City, Mar. 9-10.

NEW JERSEY SEWAGE WORKS ASSOCIATION, annual meeting, Stacy Trent Hotel, Trenton, N. J., Mar. 10-11.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS, annual convention, Hartford, March 15-16.

NEW JERSEY MOSQUITO EXTERMINATION ASSOCIATION, annual meeting, Hotel Chalfonte-Haddon Hall, Atlantic City, March 23-25.

MICHIGAN SEWAGE WORKS OPERATORS ASSOCIATION, annual conference, Lansing, Mar. 31-April 1.

MICHIGAN ENGINEERING SOCIETY, annual meeting, Grand Rapids, April 7-9.

GREATER NEW YORK SAFETY COUNCIL, annual convention, Hotel Astor, New York City, April 19-21.

SECTION MEETINGS, American Water Works Association:
New York, Jamestown, Mar. 17-18.
Louisville, Ky.-Tenn., March 21-23.
Canadian, Windsor, Ont., Mar. 23-25.
Illinois, Decatur, April 5-6.
Indiana, West Lafayette, April 7-8.
Pacific Northwest, Spokane, May 19-21.

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Examinations, Short Courses

IOWA: Examination for professional engineering, Mar. 22-23, and for land surveying, Mar. 24, Des Moines.

CORNELL UNIVERSITY, short course for sewage works operators of New York State, March 14-26.